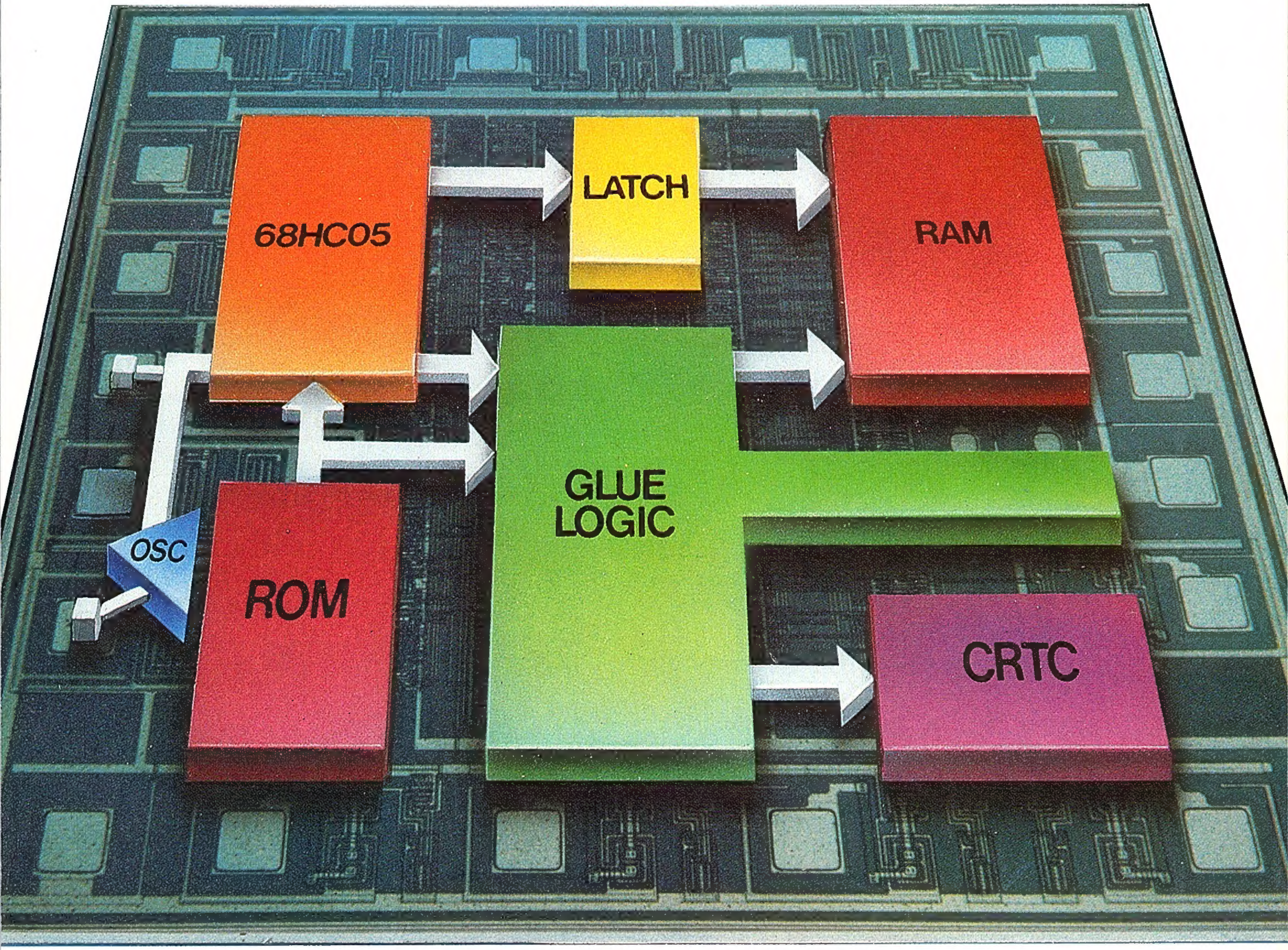
Assembly Engineering

A HITCHCOCK PUBLICATION FEBRUARY 1988



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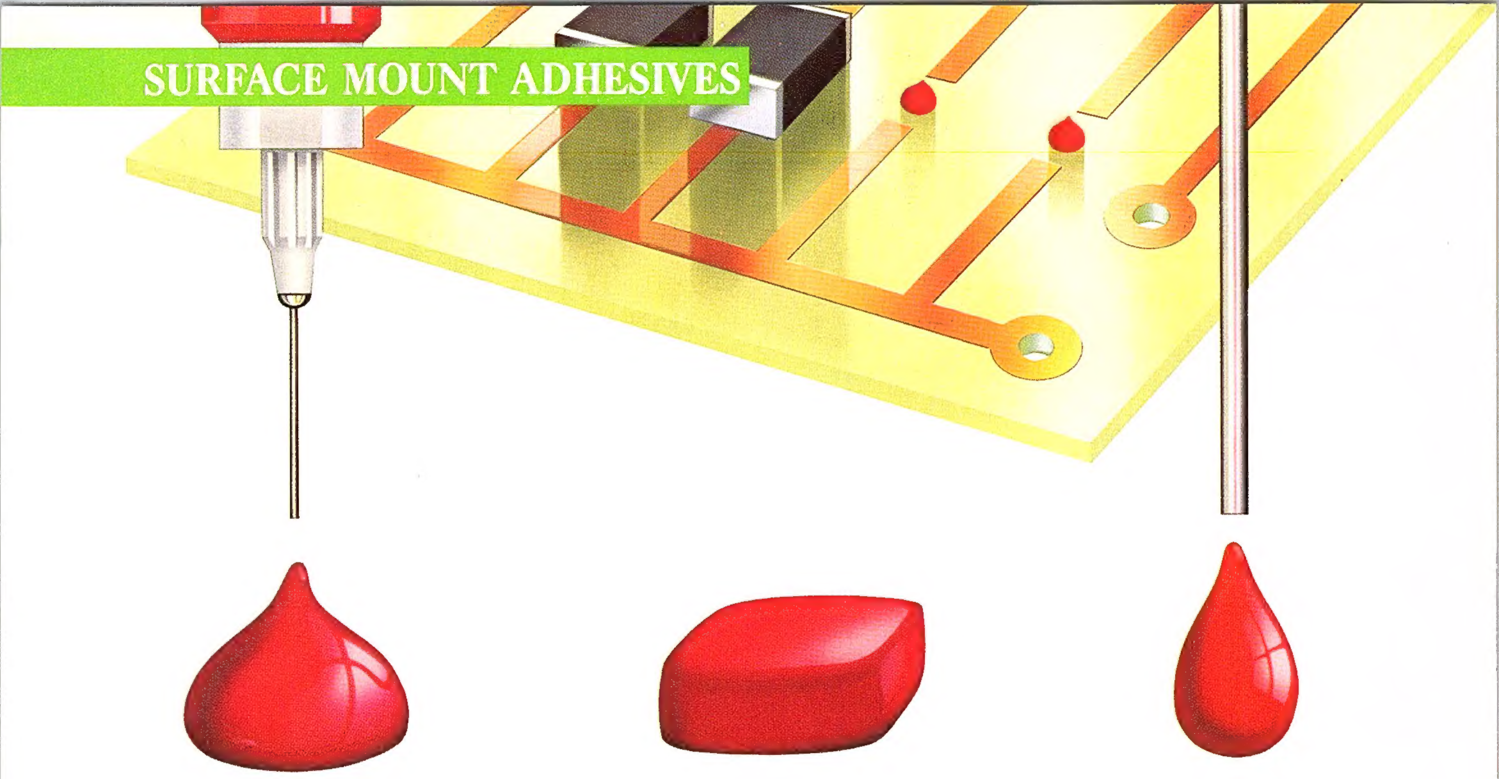

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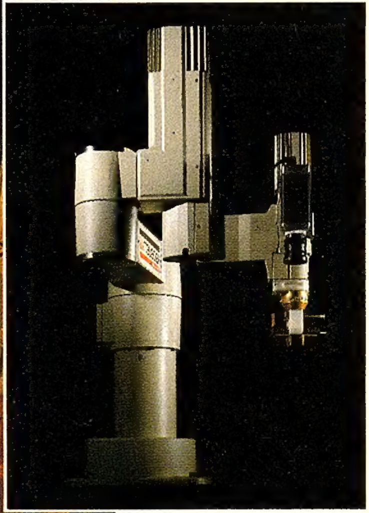

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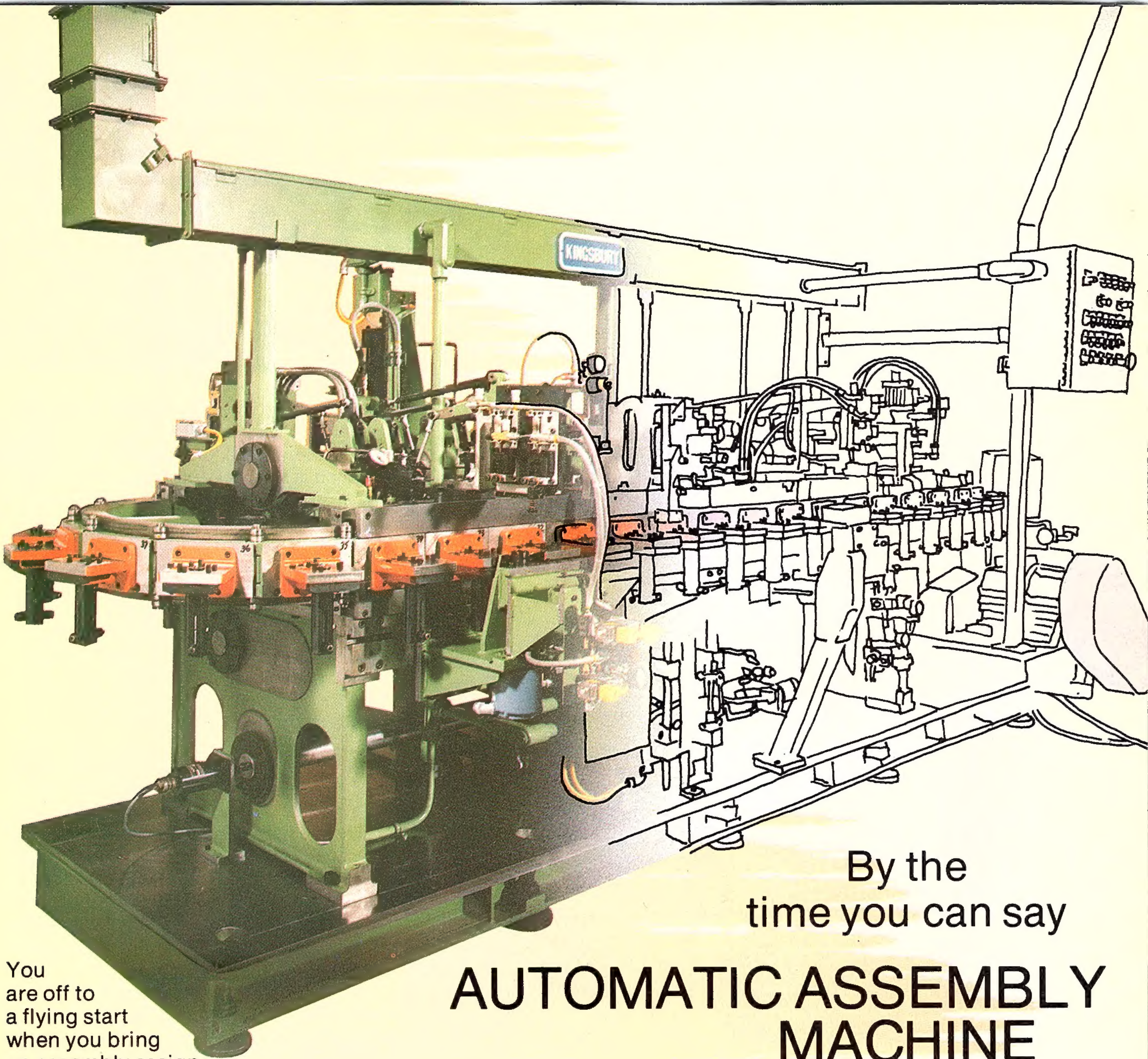

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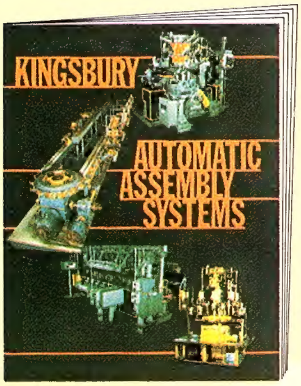

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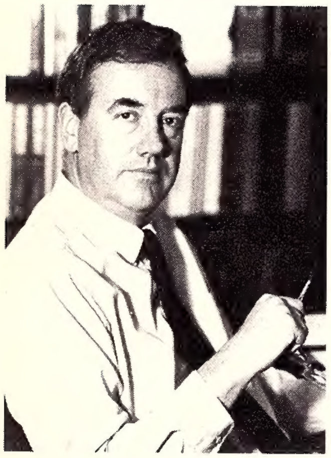

Walter H. Schwartz

Walter H. Schwartz
Senior Editor

Electronics: Design = Assembly

This month we take our first look at one of the factors that almost surely will dramatically affect the way many electronics products are assembled.

The application specific integrated circuit (ASIC) by allowing (perhaps requiring ?) the development of entire systems within a single chip of silicon, throws much of the responsibility for assembly upon the circuit designer.

These devices still require a considerable amount of external interconnection with other devices and components. However, a little farther down the line, hybrid integrated optical/electronics may greatly reduce this.

Devices have been proposed that include optical waveguides on the same silicon chip as electronics circuitry. Blocks of electronics would be interconnected by optical links; external conductors on pc boards would not be necessary.

We can imagine, for example, a small yet extremely powerful computer comprising one large optical/electronic IC mounted on a pc board to enable the connection of peripherals, one big IC in a box shared with a power supply. And—at least some of the connections to the IC could be optical not electronic.

Integrated optics and hybrid optical/electronic devices will play a major role in the computer field within a few years. Where else will such techniques be used? No one seems willing to speculate. Wherever they are though, system design will more than ever dictate manufacturing processes.

ASICs, by allowing the development of entire systems within a single chip of silicon, throw much of the responsibility for assembly upon the circuit designer.

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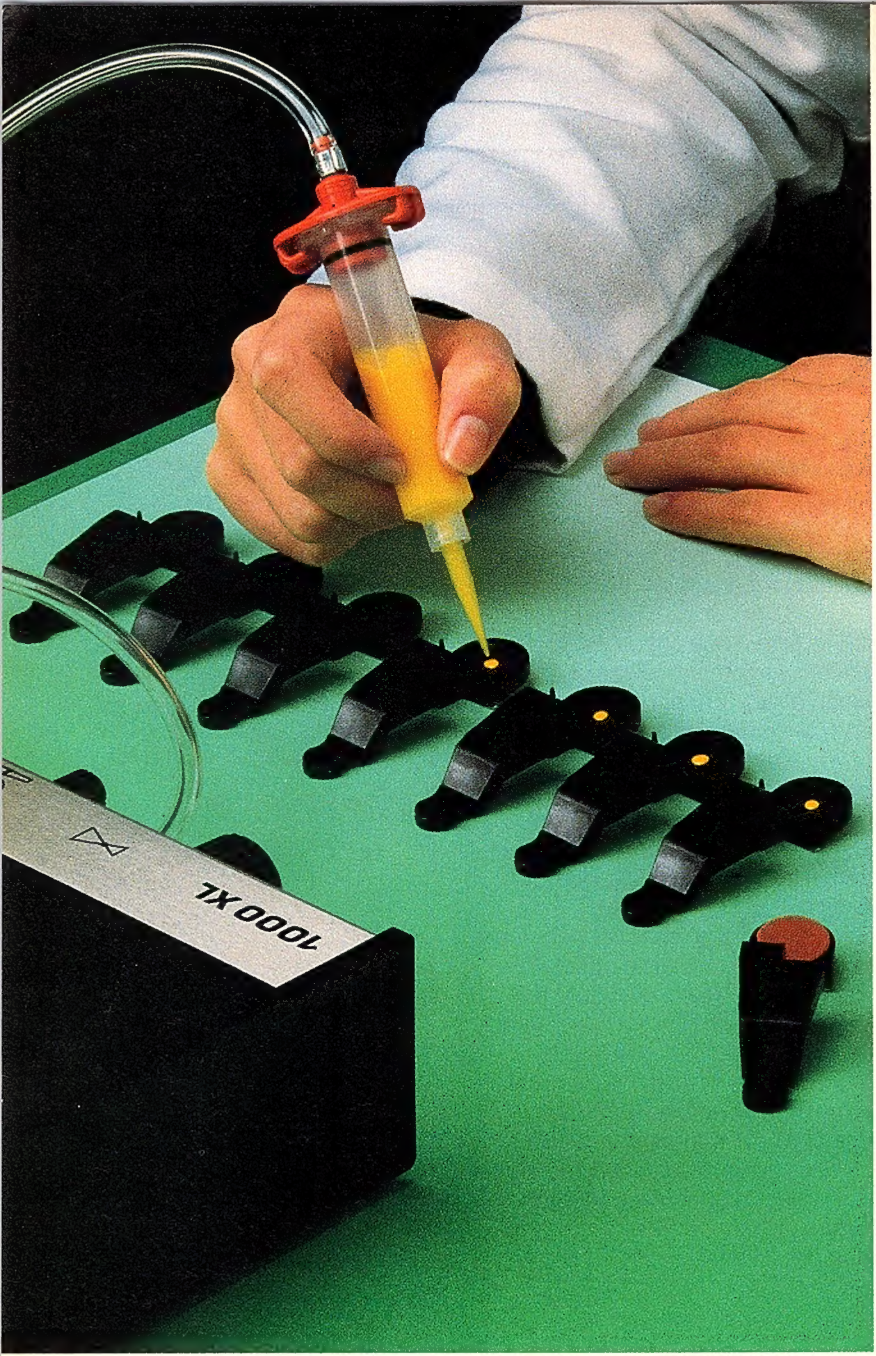

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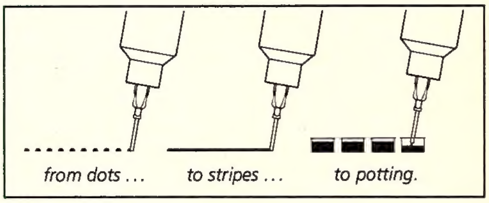

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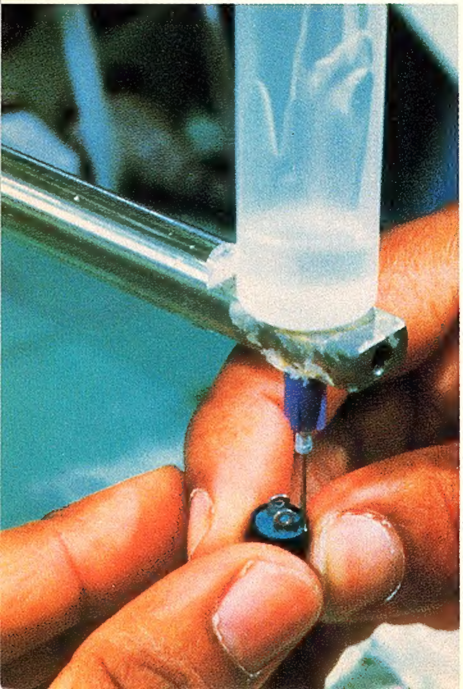
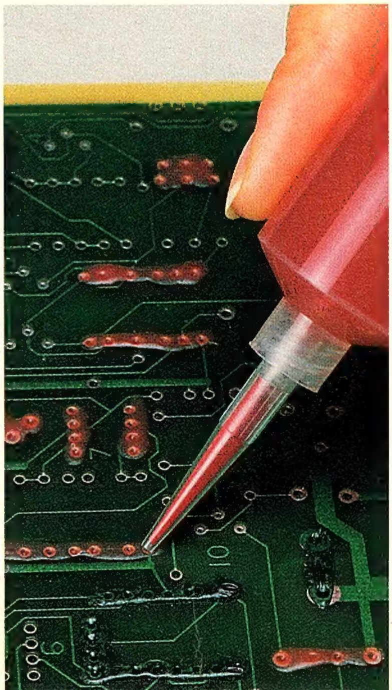


Photo courtesy of Dow Corning Corp.



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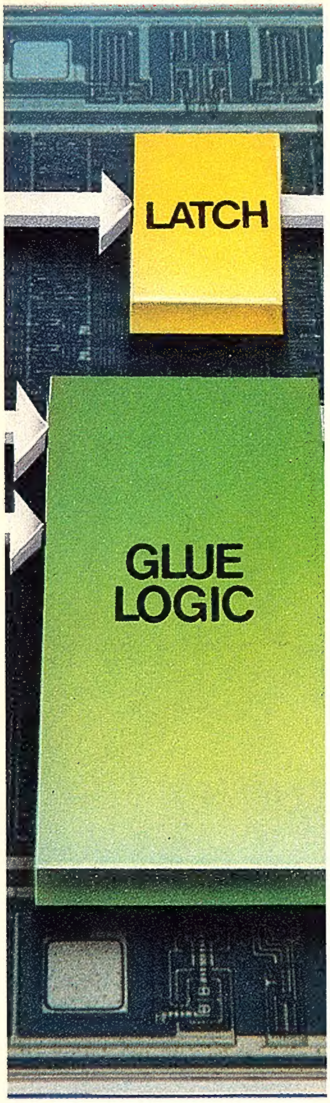

Standard cell-based application specific integrated circuits (ASICs) offer potential to consolidate functions within the IC, thus reducing pc board assembly problems. Photo: Motorola Semiconductor.

FEATURES

22
An ESD Tutorial
An educated work force is the best protection against electrostatic discharge.

30
High Density Electronics Packaging
Here are several techniques to reduce pc board parts count and simplify assembly.

38
Electronics Connector Update
A quick look at the 20th Connector Study Group Symposium.

44
What Are My Options?
Plastic fasteners can reduce electronics assembly weight, while providing adequate support and retention. Includes examples.

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DEPARTMENTS

3
VIEWPOINT
Electronics:
Design = Assembly

8
NEWSLINE
Mittelstadt Goes To D.C.
Summit Avalanches On R&D
Further Fastener Fail-Safes
Now Russia Can Kanban
Robot Survey Results
Imports Impair Welding

16
COMING EVENTS

18
SMT TODAY
Design For Producibility

52
ASSEMBLY CLINIC
One Smart System
Headlight Assembly
Predictable Precision Parts
Cutting Assembly Time
On-line Assembly Expert
Tale of the Tape

60
NEW PRODUCTS

81
FREE LITERATURE

84
ADVERTISERS INDEX

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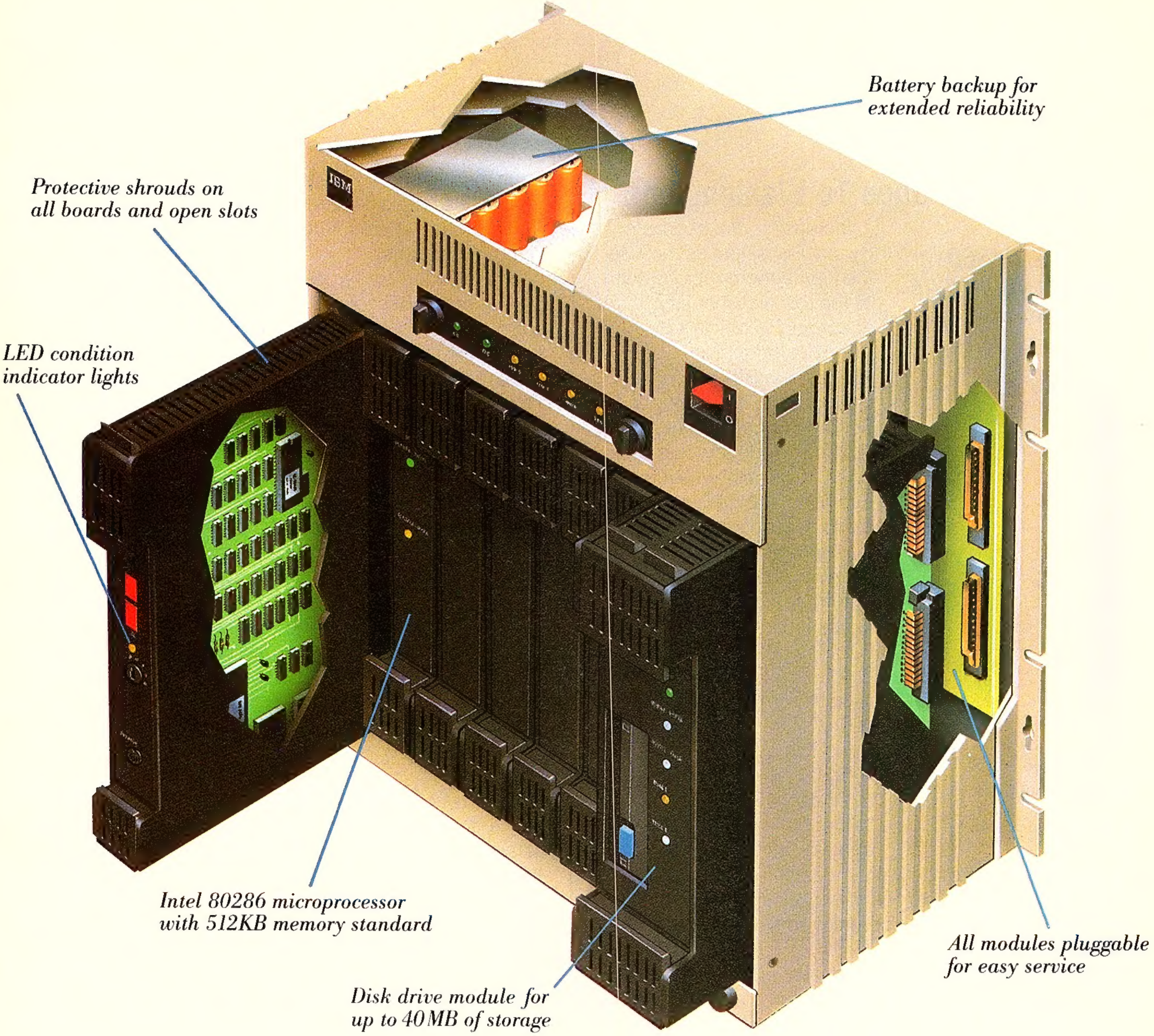

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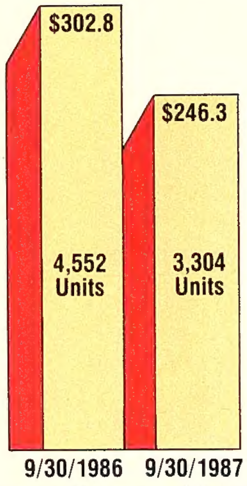


Through September 30, 1987

Source: Robotic Industries Association

Increasing use of robots by small businesses may be the key to more rapid growth of the robotics industry, according to officials of Robotics Industries Association (RIA).

Appearing before the Senate Subcommittee on Technology, Innovation and Productivity, RIA President Eric Mittelstadt reported that the U.S. robotics industry was going through a difficult financial period, with an upturn dependent upon increased usage by the 60,000 to 70,000 companies in America that would benefit from using robots, but who aren't currently using them.

Following the hearing, RIA Executive VP Donald A. Vincent released third quarter 1987 robot sales and shipment figures that show the industry running well behind 1986. He said that RIA is encouraged by the Senate's interest in the problems of small business automation.

"There are many excellent examples of small businesses that have successfully automated. Any government effort that focuses more attention on this issue can only help advance the speed at which America automates. While we welcome the restoration of investment tax credits for automation purchases, the current political climate makes this an uphill struggle. We hope to see an upturn by mid-to-late '88, with further growth among nonautomotive users leading the way."

Summit Avalanches on R&D

Despite a compromise agreed to last year by the leadership of both the House and Senate tax writing committees, the Treasury Department and the business community, proposed IRS regulations under Section 861 of the new tax code will treat a portion of U.S.-incurred R&D as if it were incurred abroad. Using the relationship of foreign-source income (i.e., income generated by overseas sales) to total company income as the guiding ratio, they would force companies to allocate a percentage of R&D expenses to foreign-source income.

"The result is more than higher taxes for U.S. companies with large R&D expenditures," explains Oliver R. Smoot, Acting President of the Computer and Business Equipment Manufacturers Association (CBEMA). "These regulations may give companies an incentive to move R&D abroad, where a foreign government may offer more favorable treatment."

The previous agreement allowed companies to allocate 67% of their R&D costs to their U.S. income. The compromise is contained in the House-passed and Senate Finance Committee-reported budget reconciliation packages. The Administration withdrew suppport for inclusion of the compromise because of its concern over less than $2 billion in "revenue losers."

"But last year's tax reform package contained over $300 billion in measures that did not raise revenues," counters Smoot. "As with the Tax Reform Act, the $2 billion in this preliminary summit package was completely offset by additional revenue raisers."

If the budget summit agreement holds and no other vehicle is found to pass the compromise, the summit action means losing several hundred million dollars in revenue annually to the information technology industry that could be used for R&D in the U.S. The result puts research-intensive companies at a competitive disadvantage in the international marketplace.

Fasteners Face Further Fail-Safes

The quality and integrity of industrial fasteners can be determined through a testing program begun by Herron Testing Laboratories, Cleveland, OH. Responding to nationwide concerns about the existence of counterfeit bolts and nuts that may fail in use (See *Assembly Engineering*, Jan. 1988, p. 42), Herron will identify suspect fasteners within 48 hrs after receiving samples.

The program offers two test options. The first procedure includes mechanical, metallurgical, and chemical analyses to determine elemental content, ultimate strength and yield properties. The second will provide only the individual property or element determinations requested by the user.

Counterfeit fasteners often exhibit mismarked bolt heads, improper plating material, and inadequate thread configuration. The most common mismarking involves Grades 8 and 8.2 fasteners; however, serious problems and failures of Grade 5 and other fastener grades have been reported as well. For more information, **circle 3**.

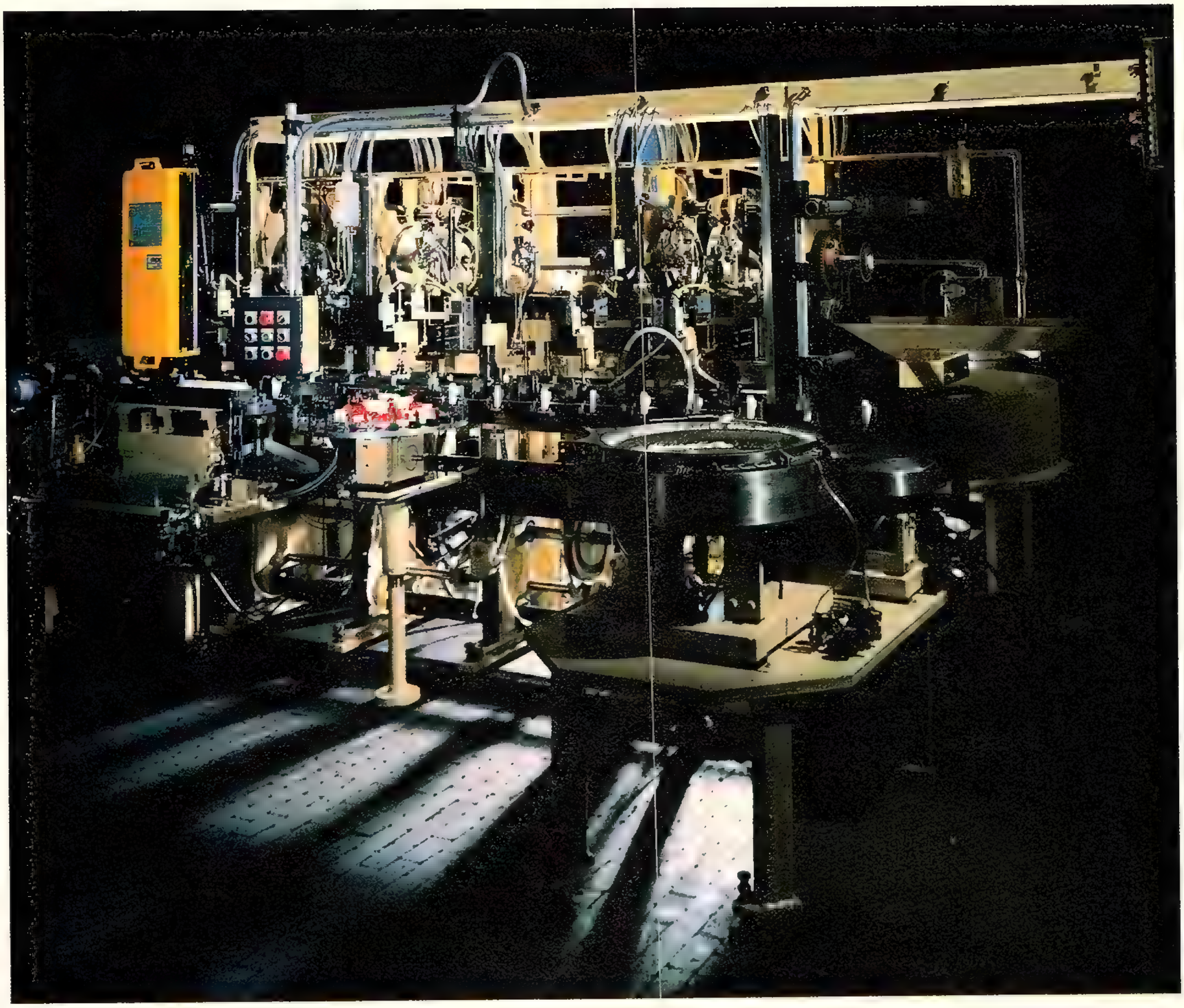
Now Russia Can Kanban

Industrial Engineering and Management Press recently announced that it has sold Russian-language rights to two books on Japan's manufacturing and management techniques to a Soviet publisher.

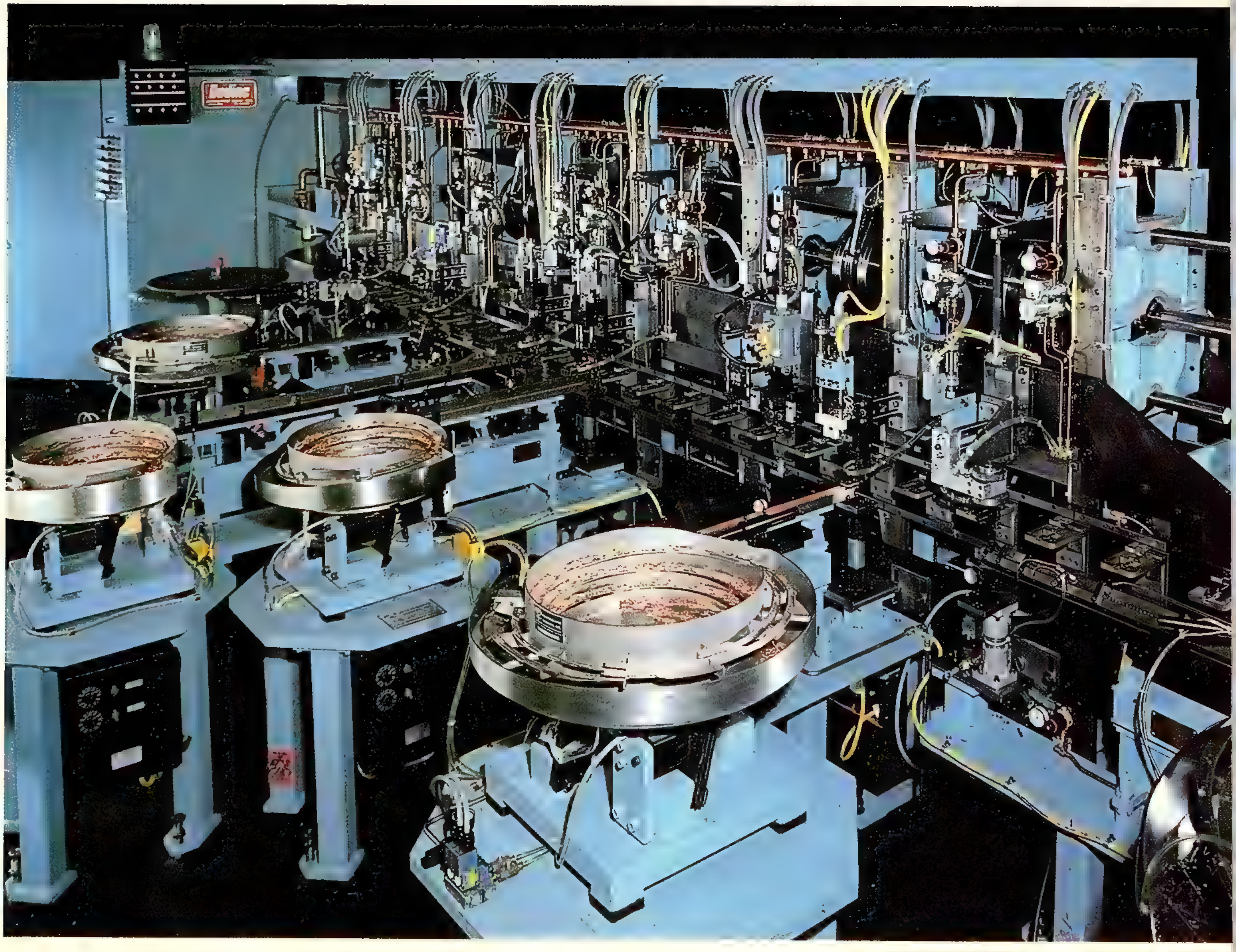
The agreement, finalized on the eve of the U.S.-Soviet summit in Washington, gives Ekonomika Publishing House of Moscow exclusive rights to publish 60,000 copies of *Toyota Production System: A Practical*

CONTINUED P. 13

Assembly Systems that Work Don't Just Happen.



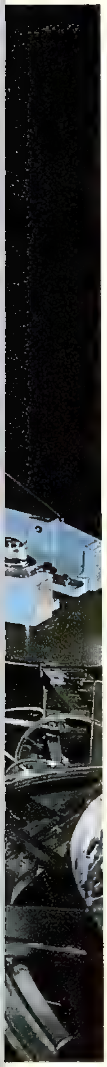
It's Time to Dispel Some Myths about Automatic Assembly.



Myth #1: All assembly automation system builders are equal.

Fact: Assembly systems work because experienced people apply proven assembly technology to specific production requirements and plant environments.

That's the way we work at Bodine. For over 50 years, we have specialized in high-speed assembly for small and medium sized parts. Industrywide. Worldwide. Bodine is recognized as the industry leader by manufacturers throughout the U.S., Australia and Japan as well as Europe and the United Kingdom.



Myth #2: "Hard" automated assembly systems aren't flexible.

Fact: The core of our system, the Model-64 machine, features versatile, dependable, cam-actuated station tooling. Bodine Assembly Systems are based on modular construction, recognizing our customers' needs for future flexibility. In fact, manufacturing cells of two or more Bodine Assembly Systems can produce thousands of different product combinations in batch sizes large or small.

Myth #3: Only the "Big Boys" can afford to fully automate.

Fact: If you are looking to automate your assembly operation, Bodine has the right system for you. Whether you are a single facility manufacturer or a Fortune 500 corporation, we offer payment terms that are compatible with your budget. Up front payment is never required with your order.

Bodine's modular construction also means reliability, high uptime and low maintenance costs. Translation? Increased profits for you.

Myth #4: "Leading edge" technologies are universally suitable for the production floor.

Fact: Start-up and maintenance of high-tech manufacturing processes can be costly and difficult without qualified technicians on site. Bodine integrates "leading edge" technologies with the assembly process, while making every effort to ensure compatibility with existing equipment, your operators and maintenance people.

Myth #5: All assembly automation builders provide ongoing system support.

Fact: At Bodine, we understand the importance of uptime on high-production equipment. We respond to customer needs immediately — with a full warehouse of standard commercial components and spare parts. Parts can be shipped domestically or overseas within 3 hours of a request.

In addition, Bodine's engineering staff will be there when product changes call for system modification. A staff of electrical and mechanical service technicians is available at all times.

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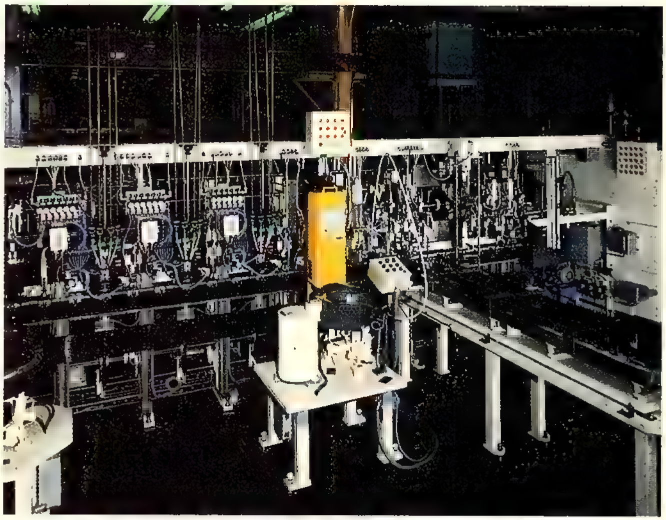

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Approach to Production Management, and 75,000 copies of *Innovations in Management: The Japanese Corporation*, in Russian.

"These books will arm Soviet industry with the tools it needs to become internationally competitive. Their initiative and persistance in negotiating this agreement speaks for their dedication to Gorbachev's policy of 'perestroika,'" says Gregory Balestrero, acting executive director of IIE.

Previous translations have been published in Japan, Italy, and Spain. Based on a series of articles by author Yasuhiro Monden, *Toyota* describes in depth the concepts of Just-in-Time production, including "kanban," "autonomation," "andon," and "shojinka."

Ekonomika plans to release *Toyota* this year and *Innovations* in 1989.

Readers Respond To Robot Survey

A survey mailed to 5000 randomly selected readers of *Assembly Engineering* enjoyed a 17% return.

Results show that slightly over 62% of those surveyed use or plan to use robots, with the most concentrated usage in the electronic computing and motor vehicle parts industries. Primary applications include parts handling or transfer (53.8%), arc welding (23.3%), sealant or adhesive application (17.9%), and inserting through-hole or placing surface-mount electronic components (17.3%). A total of 2246 robots are currently in use by those polled, and 6035 is the projected figure for 5-10 years from now. Average dollars spent in the last five years was $507,000.

The report indicates 83 of the 311 robot-users also use vision systems while another 153 are warming up to the concept. Major manufacturing applications are measuring dimensions (44.4%), inspection (41.9%), detecting presence or absence of parts (35.5%), and robot guidance (25%).

Winner of the incentive to respond to the survey, a personal color television, is Maurice LeClair, general manager of AT&G Co., a manufacturer of screwdriving and nutsetting tool bits.

Imports Stall Welding Industry

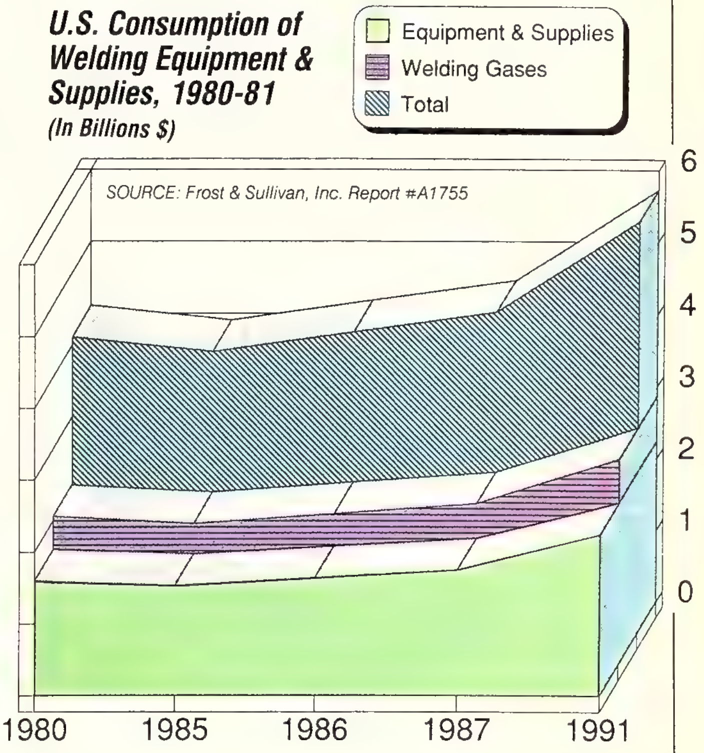
The 1980s surge of manufactured imports such as automobiles, trucks, and machinery has not only pounded those core U.S. markets, but struck hard at dependent peripheral markets. Welding equipment and supplies are a prime example.

A 251-page report from Frost & Sullivan, *Welding Equipment and Supplies Market (#A1755)*, cites 1980 revenues of $2.3 billion, using 1982 constant dollars. By 1985, the market was down to $1.82 billion, a real decline of 3.6% a year.

In 1986, however, the market turned up slightly to $1.87 billion. For the future, the report forecasts continued modest growth of 2.1% a year (constant 1982 dollars) to $2.1 billion by 1991. In current dollars (including inflation), the forecast is for 6.4% yearly growth from $2.09 billion in 1986 to $2.86 billion by 1991.

The market is getting help in manufacturing end-use sectors from a weakening dollar's effect on imports and exports. Also, other end-use sectors less vulnerable to imports (e.g., construction) are becoming more significant.

An examination of the market by products and processes finds that arc welding devices and consummables continue to maintain a dominant market position, vis-a-vis gas welding, resistance (spot) welding, and other processes. Arc welding sales accounted for about 68% of the hardware market in 1980, expanding to about 72% in 1986.

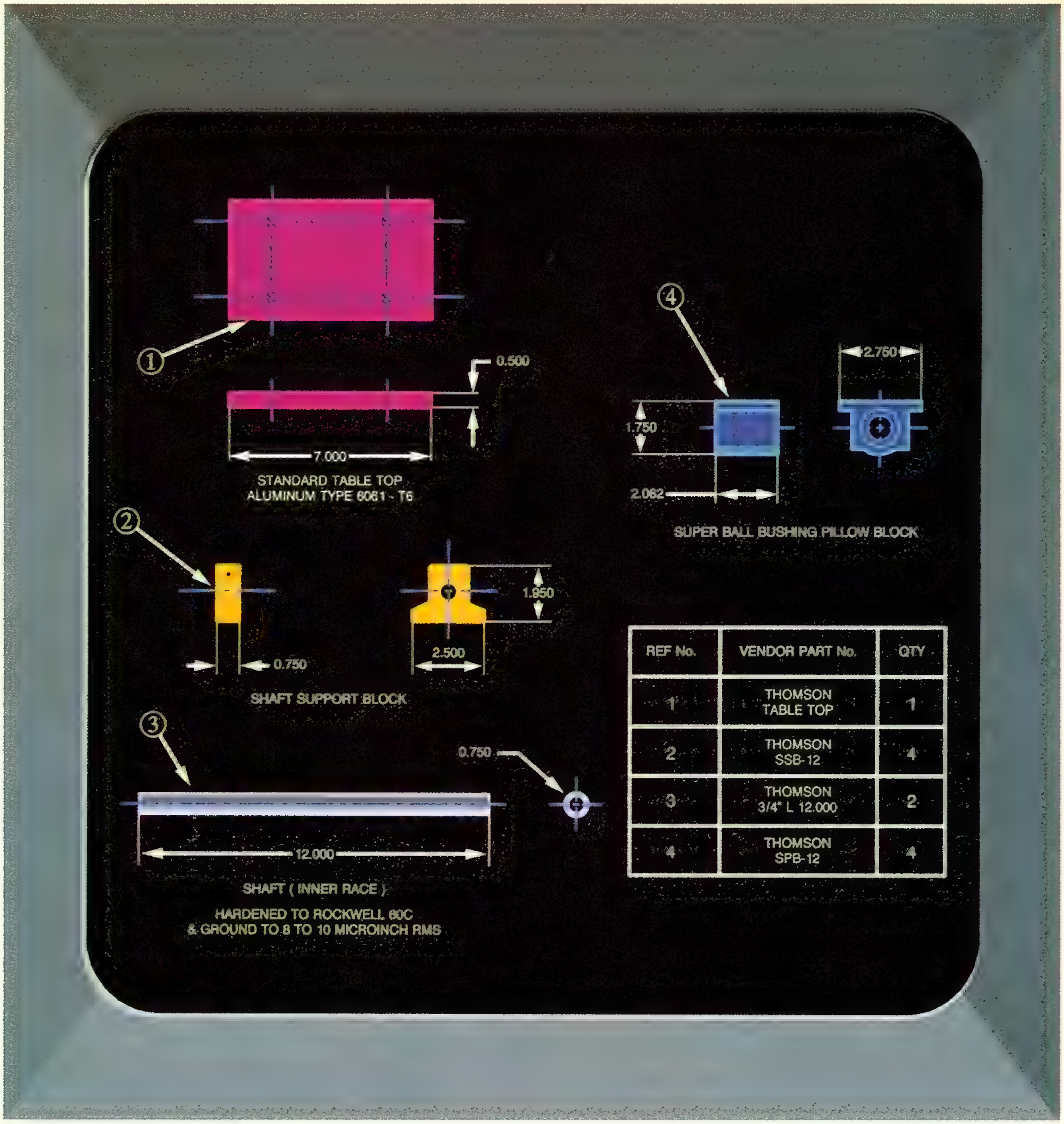


U.S. Consumption of Welding Equipment & Supplies, 1980-81
(In Billions $)

SOURCE: Frost & Sullivan, Inc. Report #A1755

The impact of factory automation has so far not been great. Because automated welding is more efficient and uses fewer accessories (no gloves or goggles), consumption tends to be proportionately less per unit of welding. Over the long run, however, the study predicts automation will have a favorable effect on the welding materials industry because it enables welding to effectively compete with alternative fastening techniques. Too, new products will certainly evolve to take advantage of new capabilities.

The *Assembly Engineering 1987 Article Index* is now available. This reference lists all articles and columns by subject, title, month and page number. To obtain a free copy, **circle 2** on the reader service card.



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2	THOMSON SSB-12	4
3	THOMSON 3/4" L 12.000	2
4	THOMSON SPB-12	4

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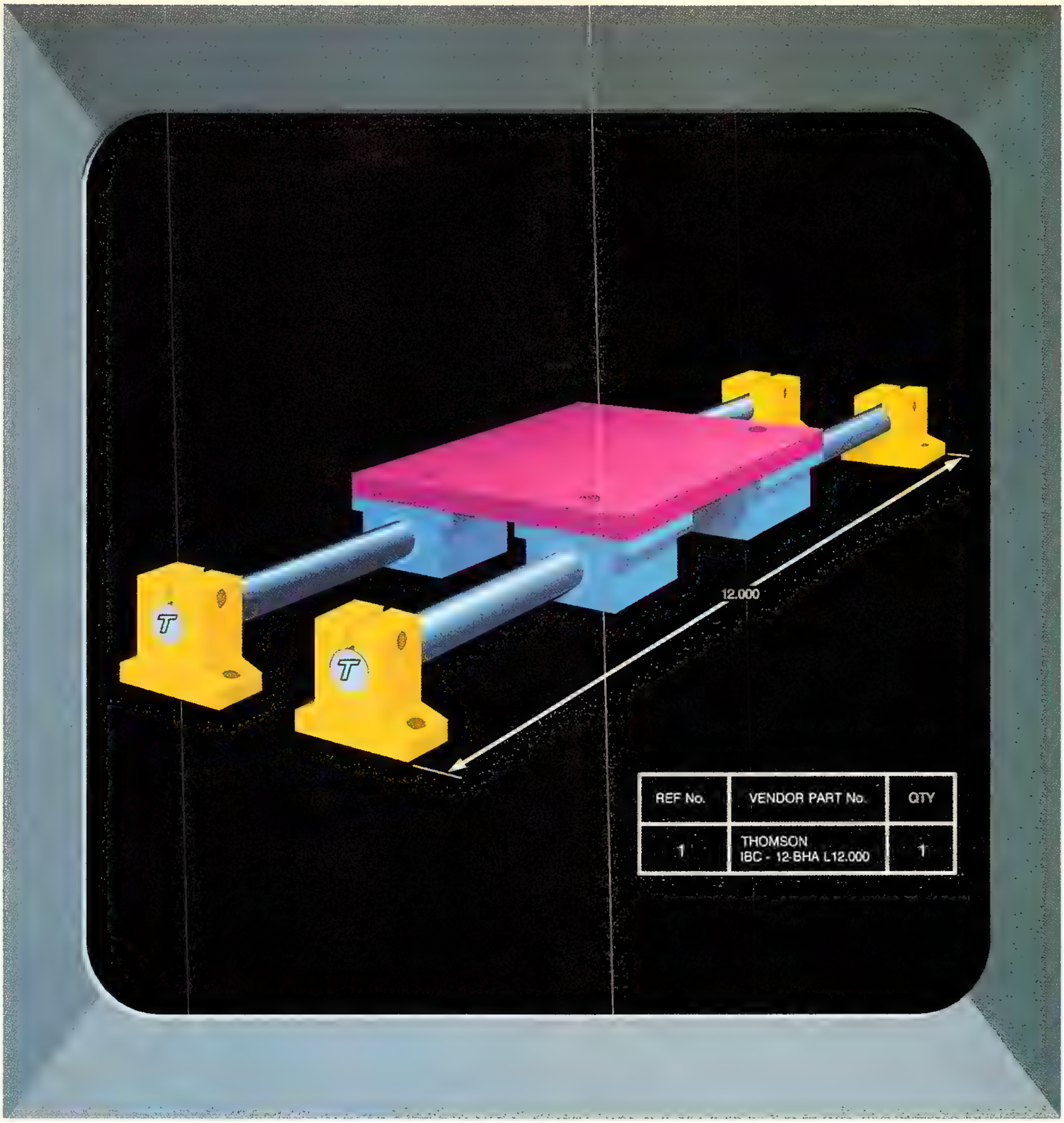

REF No.	VENDOR PART No.	QTY
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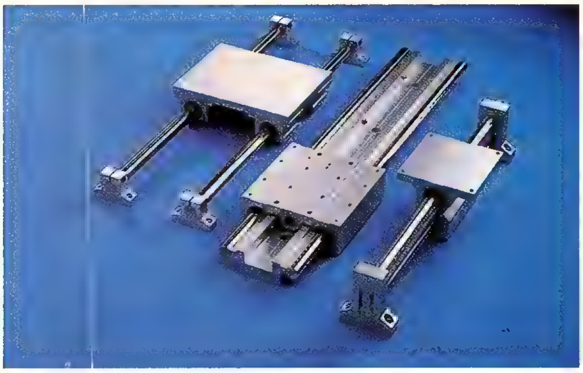

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Coming Events

Planning for CIM: The Manager's Role in Factory Automation. Feb. 22-23, Boston, MA; Feb 25-26, Chicago, IL; Mar. 1-2, Los Angeles, CA. Contact: Kim Gay, Cutter Information Corp., 1110 Massachusetts Ave., Arlington, MA 02174, (617) 648-8700.

Manufacturing Automation Protocol—Plant-Wide Design and Planning. Feb. 23-25, Los Angeles, CA. Contact: Susan Balbaugh, SME, Professional Education Department, One SME Dr., P.O. Box 930, Dearborn, MI 48121, (313) 271-1500.

Developing Practical Artificial Intelligence Strategies for Manufacturing. Feb. 24-25, Los Angeles, CA. Contact: SME, Professional Education Department, One SME Dr., P.O. Box 930, Dearborn, MI 48121, (313) 271-1500.

Successful Automatic Assembly Systems. Feb. 24-25, Los Angeles, CA. Contact: Susan Balbaugh, SME, Professional Education Department, One SME Dr., P.O. Box 930, Dearborn, MI 48121, (313) 271-1500.

1988 SAE International Congress & Expo. Feb. 29-Mar. 4, Detroit, MI. Contact: Barbara Pontell, Manager, (412) 776-4841.

Machine Monitoring Sensors for Untended Manufacturing. Mar. 1-3, Cincinnati, OH. Contact: Dianne Leverton, SME, One SME Dr., P.O. Box 930, Dearborn, MI 48121, (313) 271-1500, ext. 383.

33rd International SAMPE Symposium & Exhibition. Mar. 7-10, Anaheim, CA. Contact: Marge Smith, P.O. Box 2459, Covina, CA 91722, (818) 331-0616.

Spring National Design Engineering Show and Conference. Mar. 7-10, Chicago, IL. Contact: Show Manager, Spring National Design Engineering Show, 999 Summer St., Stamford, CT 06905, (203) 964-0000.

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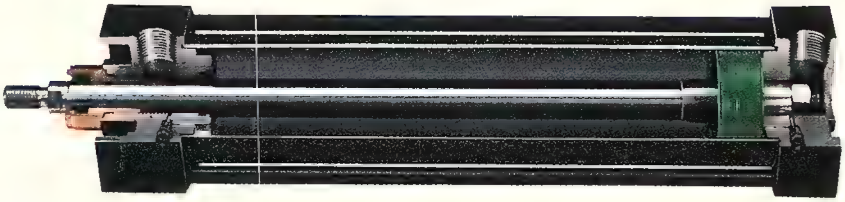

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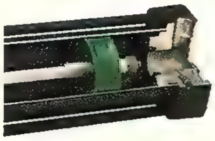

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Design For Producibility

Charles-Henri Mangin, CEERIS International, Inc.

Good SMT design can only happen through coordination with manufacturing. The best possible design is of little value if the board cannot be produced at a competitive price.

The design of SMT boards is more intimately involved with manufacturing than is conventional through-hole technology. Good design of SMT assemblies, therefore, means that circuit layout must consider processing, testability, and reworkability constraints. For any given assembly, it is necessary to decide a range of issues (summarized in the table). The critical difference in SMT is the closer packing densities, closer pad spacing, and finer lines and spaces used.

These higher real estate densities affect drastically the performance of the assembly process, especially with respect to solderability and testability. A successful design will be the result of numerous trade-offs. Increased electrical performances and dense real estate must be traded against the actual producibility of the design. Solderability and testability are probably the two most critical issues. The number of solder joints is so large that poorly designed boards are likely to test bad. Access to adequate nodes is crucial to identifying defects and process monitoring.

Newly SMT-designed boards offer an opportunity for improving board size and component usage standardization. Understanding the PCB design requirements also favors the implementation of a specific and most effective assembly system.

SMT Design Issues

PARAMETER	*COMMENT*
Footprint design	Need placement accuracy and high design soldering yields (from large footprints) versus packing density of board (from small footprints). Design of sub-patterns (load, resist, paste) necessary with clearances. Small footprints may be required if between-pad tracking is used. Large extended footprints are needed for wave-soldered components to enhance wetting. High aspect ratio footprints may promote component float-offs or tombstoning.
Track and via design	Board increasingly more manufacturable with 0.008 in. and greater lines and spaces. Many design rules in use: commonest is 0.010 in. lines and spaces; 0.004 in. track possible. In-pad vias not recommended (may need very small drilled hole plus possibility of starving joint of solder). For multi-layer boards tracking should be symmetrical on both sides to avoid warping.
Routability	Component packing, footprints, and through-holes obstruct routability. Package selection should allow for routability issues. Extreme obstruction requires a multi-layer design. Via implementation will cause parallel tracks to spread out.
Manufacturability	Automatic placement is more efficient with grid layout of standard size; efficiency also relates to number and mix of components. Mixed technology with cut and clinched leaded components will affect SMD placement. Component orientation and pitch may be especially important for wave soldering. Solder starvation of lands increased if large width connectors are used between them.
Electrical considerations	All SMDs possess lower parasitic values than through-hole counterparts, leading to, for example, faster switching of digital circuits. Compact board layout increases circuit speed further; however, close spacing if pads are conductive may promote undesirable coupling and complicate placement.
Thermal considerations	Compact layout promotes hot spots along with small package sizes. Heat sinks may be necessary. Board/package interface may suffer from fatigue due to thermal cycling. Compatibility between component and board material is required. Interboard dissipation is favoured by close contact (small stand-off height), but this restricts cleaning efficiency. Wide through-holes under large components may alleviate this.
Testability	Test pads should be included on major nodes or blind vias. A 0.100 in. pad pitch is most cost effective for fixture construction, and pitches closer than 0.050 in. should not be used. Nodes should be accessible on one board face only. Component leads should not be probed (there is no hit guarantee). Test pads should not be grouped on one area (probing may flex board). Pads should be sited away from high-profile components.
Inspectability	Densely packed boards are difficult to inspect, especially if leadless packages essentially cover up nodes. Joint inspection is also difficult under these circumstances. For complex ICs, the choice is between IL and MIL footprint formats.
Reworkability	Reworkability becomes more difficult with dense-board packing: it is difficult to clearly remove and replace components, and other components or the board itself may be damaged.
Designing for productivity	Production sets constraints designers may not ignore.

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An ESD Tutorial

Avoiding a Breakdown

Fred Cheyette
Consultant, (Formerly, Chairman, ESD Committee,
Simmonds Precision Products,
Instrument Systems Div.)

Despite the publicity that ESD has been given recently, many don't have a basic understanding of it. The purpose here is to provide answers to commonly raised questions about ESD in the electronics industry.

What is It?

ESD stands for Electrostatic Discharge, which is the release of a static electric charge—a charge at rest. Substances with an excess of electrons are negatively charged; those with a deficit are positively charged.

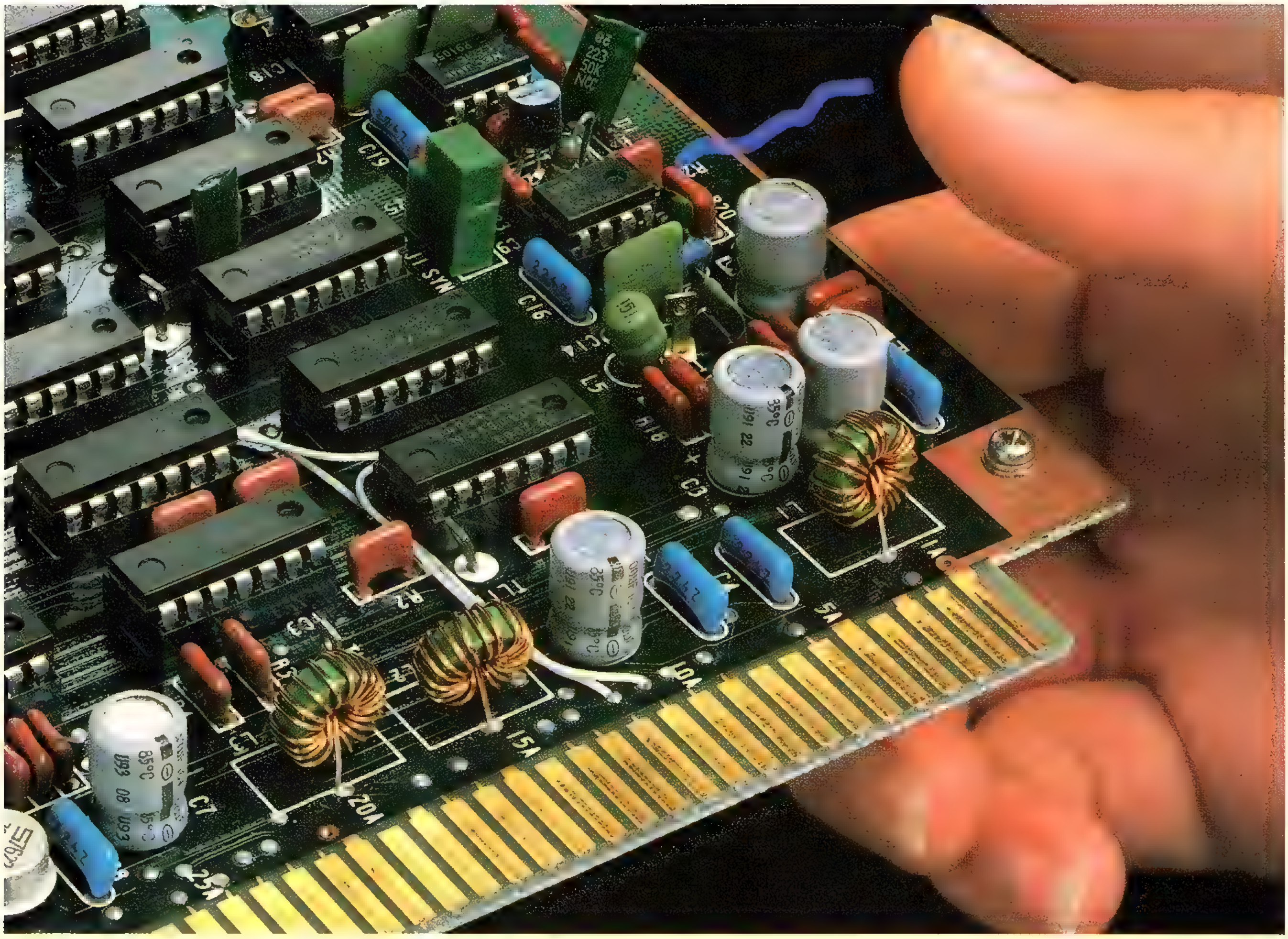
Electrostatic discharge occurs when a charged object is brought near or touches another object with a different electrical charge. The electrons flow from the negative object to the positive to establish equilibrium.

When you walk across a carpet on a dry day your body becomes highly charged. When you reach for a doorknob, you discharge to it and see a spark, and get a shock. In the same way, a charged object will discharge to an electronic component. The spark is due to the magnitude of the discharge, but the discharge is always occurring.

Static electricity discharges in microseconds (millionths of a second). The current can be as great as 60 amperes during the initial part of the discharge. Compare that to the size of the fuses or circuit breakers in your home!

The ESD Problem

Several years ago I watched an engineer pick up diode after diode with



his hands and test them with an ohmmeter. After 22 in a row had failed, he stopped cursing the manufacturer and realized that perhaps it was his handling that was the problem. It was an expensive way to become aware of the damage ESD can do.

ESD has been causing problems for the plastics and film industries for decades. The gunpowder industry has known about ESD since fireworks were invented by the Chinese.

All electronics parts are subject to ESD damage, depending upon the amount of voltage to which they are subjected. The concern is for those parts that can be damaged by relatively low voltages. Remember, although the voltage may be low, the current momentarily will be high. It is the power that does the damage.

Large components usually require over 4000 volts to cause damage; very small components can be zapped by 20 volts or less.

To put things into perspective, MOSFETS (Metal Oxide Semiconductor Field Effect Transistors) have insulation layers that are 1000 angstroms thick (one 1300th the thickness of a human hair). It only takes 100-200 volts to blow a hole in this layer. Newer devices have insulating layers that are even thinner, and can be damaged by as little as one volt.

Device and equipment failures due to ESD are estimated to be in excess of $5 billion a year. This figure is extrapolated from the failure analyses performed on many devices.

We don't know the real numbers, since failure analysis is expensive, time consuming, and not often done. The figures may be higher, since many failures are probably categorized as random defects, infant mortality, or manufacturing defects.

What Causes ESD?

Two steps are required: generating static electricity and affording it an opportunity to discharge.

Static electricity can be generated by:

- Rubbing two materials together
- Separating two materials
- Flowing gas or liquid over a surface. Be aware that when you are filling a gas can, you should touch the nozzle of the gas pump to the container to prevent a spark from jumping across.
- Heating and cooling materials with large coefficients of expansion

A conductive material will spread the charge uniformly over its surface. A nonconductive material will keep the charge localized at the area of contact. Therefore, static electricity can be generated by rubbing or separating different areas of the same nonconductor.

THE TRIBOELECTRIC SERIES

Air
Human hands
Asbestos
Rabbit fur
Acrylic
Phenolic
Cellulose acetate
Glass
Quartz
Mica
Human hair
Nylon
Wool
Fur
Lead
Silk
Aluminum
Paper

Cotton
(Reference Point)

Steel
Wood
Amber
Sealing wax
Hard rubber
Nickle, copper
Brass, silver
Gold, platinum
Sulfur
Acetate rayon
Polyester
Celluloid
Orlon
Saran®
Polyurethane
Polyethylene
Polypropylene
Polyvinycloride
Silicon
Teflon®

There is an electrostatic field between two bodies at different charges. Discharge takes place either when the bodies touch or when there is sufficient difference in the charges to overcome the resistance of the air between them. (Remember reaching for the doorknob).

Note that when an electrostatic field exists between two bodies, a third body that passes through the field will be charged by induction. Contact is not necessary.

The Triboelectric Series

This is a listing of materials arranged in order of their capability to hold an increasingly positive or negative charge. Virgin cotton is used as a reference, since its tendency to absorb moisture minimizes its ability to hold a charge.

When reading the series, the greater the distance there is between two materials, the greater the charge that can be built up. Think of this the next time you see someone stripping Teflon™ insulation off wires. Human hands and Teflon are at the opposite ends of the series.

Consider the following: Paper work instructions are slid into a vinyl folder (rubbing), which is peeled apart (separation), and the instructions slid out (separation and rubbing). Checking the triboelectric series we see that paper and vinyl are far apart; the possibility for ESD is very high.

Failure Modes

There are four types of failures associated with ESD:

- Catastrophic means the device no longer works. An example is a diode that has been punched through.
- Measurable Degradation means that the device still works, but with lessened capability. This effect can be seen when transistor characteristic curves change.

Both of the above can usually be caught before the product goes out the door.

- Upset is reversible. An example is the loss of memory in a digital circuit.
- Latent defects are those that are initially invisible. A device with a latent defect may operate for months or even years, and yet fail at any time. An MOS or similar device may have a latent defect if the insulation layer is punched through by ESD. As it is subjected to operational voltages and/or elevated temperatures, metal migrates into the hole and eventually shorts it.

For many years industry thinking was that 50% of field failures were due to latent defects. Some ESD experts now believe this was overstated, and the real figure is only 2% or less. However, the Navy now claims that 80-90% of field failures are ESD related, and is acting to provide protection for less sensitive devices.

ESD Protection

All susceptible devices are fully protected when they are completely surrounded by a conductive material. Such protection is called a Faraday cage. To prove his contention that such a cage will protect whatever is in it from an electrical discharge, Michael Faraday had one built large enough for him to get inside and had it struck by lightning. He walked away unscathed. Conductive ESD bags and totes do the same for electronic components.

Devices can be protected outside this cage by keeping all charges away from them.

This is accomplished by:

- Grounding the person handling the part
- Grounding the work surface upon which the part rests
- Keeping charged materials away from the part

All ESD protective devices are aimed at performing these tasks.

An educated work force is the best protection against ESD. When all members of the work force are aware of the need for protection and follow proper handling procedures, the battle is nearly won. Training must include everyone who comes near susceptible devices including supervisors, dispatchers, managers, customers, visitors, vice-presidents, presidents, photographers, maintenance people, everyone!

If you can't train them, for example a contract janitorial force, then you must defend against them. The trained people must always put the susceptible devices into an ESD bag or box at the end of the workday, and the trash can liners must be made of anti-static materials to prevent generation of high voltages when the janitor snaps open the bags.

RELATIVE COMPONENT SUSCEPTABILITIES

CLASS 1 devices sensitive from 1 to 1,000 volts are:

- MOS without protective circuitry
- OPAMPS with unprotected MOS capacitors
- JFETS (Junction Field Effect Transistors)
- Microwave and UHF devices
- LSI (Large Scale Integration) circuits
- VLSI (Very Large Scale Integration) circuits

CLASS 2 devices sensitive from 1,000 to 4,000 volts are:

- Schottky diodes
- Precision resistor circuits
- TTL (Transistor to Transistor Logic) circuits
- ECL (Emitter Coupled Logic) circuits

CLASS 3 devices sensitive from 4,000 to 15,000 volts are:

- Small signal diodes
- Chip resistors
- Low power silicon transistors
- Piezo-electric crystals
- Silicon rectifier and fast recovery diodes

Specific Protective Devices

There is no simple answer for all situations. The mobility of the operator often dictates the protective measures to use.

When operators sit down and work with components at benches, basic protection consists of an anti-static mat connected to ground, and a conductive wrist strap on the operator's bare wrist also connected to ground.

In areas where people are always moving around, such as stockrooms, protection is provided by putting conductive material on the floors and having everyone wear conductive heel straps or shoes.

In areas where neither wrist nor heel straps are practical, ionizing air blowers can be installed to neutralize static charges. The drawback to ionizers is that they take longer to neutralize the charges than it takes to build them up.

There are actually three categories of material used for ESD protection, classified by surface resistivity. The units are expressed in powers of 10, such as 10^3 ohms per square, or 1000 ohms.

Conductive material measures from 10^3 to 10^5 ohms per square. It may be bulk conductive plastic or laminates or metal wire impregnated materials. It drains off charges quickly and is used to make Faraday cages in the form of bags, boxes, and totes. If the resistivity is less than ten to the third power, it may allow charges to drain off so fast that the current may damage sensitive parts.

Static dissipative material measures from 10^5 to 10^9 ohms per square. It drains off charges fast enough to protect the parts and slowly enough to prevent damage.

Anti-static material measures from 10^9 to 10^{14} ohms per square. The advantage of this material is that it will not generate a static charge. One disadvantage is that it cannot form a Faraday cage. Most of the pink materials are anti-static. These are made with a detergent material that bleeds to the surface creating a "sweat layer," through which the charges travel. Another disadvantage is that the detergent has a finite life, and is dependent upon humidity. Under low humidity conditions the material may be good for no more than three months. Pink material should be checked with a static meter when it is received and periodically thereafter.

Insulating material is anything over 10^{14} ohms per square. These hold charges for long periods. They should be kept away from unprotected ESD susceptible components. Styrofoam and vinyl are two of the most common and worst offenders. (There is a lack of agreement on exact definitions of these materials. See "The Doorknob Syndrome," Sept. '86, *Assembly Engineering.)*

It's in the Bag

To protect a susceptible device a three layer bag is needed. The inner layer must be anti-static or static dissipative to prevent the device from generating a charge when it is slid into the bag. The middle layer must be conductive to provide Faraday cage protection. The outer layer must be anti-static or dissipative to prevent charge buildup when the bag is handled. Before deciding on a bag, rigorous testing should be done to insure that it actually will protect parts.

To keep insulating materials off the work area, non-susceptible items must be packaged in anti-static materials. Screws, washers, etc. can be placed in inexpensive anti-static bags. The stock of bags should be periodically tested to make sure they are still useable.

Air Ionizers

Air ionizers work by putting out a stream of both negative and positive ions. When they hit a charged object, the charges are neutralized. As ions leave the ionizer they start to disperse. As their number per unit area decreases, the time it takes to neutralize a charge increases. Ionizers are effective within 2 to 3 feet. There is charge dissipation at greater distances, but at a slower rate.

Most ionizers have built-in fans to blow the ions over the work area. This can be distracting to the person working in front of the blower. In addition, if soldering is being performed in the air stream, it may affect the solder joints. Many ionizers now have heaters to overcome these problems.

There are two basic types of ionizers: electronic and nuclear. The nuclear ionizers can only be leased, and the radioactive material must be renewed yearly.

Electronic ionizers work by sending a high voltage to a sharp point, which ionizes air. They have both positive and negative power supplies, and the currents are sent to different points. These points degrade over time, reducing the efficiency of the ionizer. Positive points wear down faster than negative. Negative points gather dust and debris faster than positive. It is important that the quantity of negative and positive ions be balanced. If the unbalance is severe, the ionizer will become a generator of static, rather than an eliminator. Testing devices are now available to measure the positive and negative ion flows.

At ISD, when a demonstration tester was brought in, two of the first three ionizers checked were severely unbalanced. Newer ionizers have devices to clean the points and to balance the positive and negative ions.

" BOSS... ABOUT THIS NEW CARPETING YOU'VE HAD INSTALLED... "

Conductive Smocks and Wrist Straps

Even though personnel may be wearing wrist straps, their clothing may be highly charged, since most garment materials are insulators. If clothing comes near an ESD susceptible device there may be a discharge, whether or not contact is made between the device and the clothing.

A conductive smock will both shield the devices from the charge held by the clothing and provide a path to ground when the smock touches a grounded bench mat.

Carbon and stainless steel are put into smock material to make it conductive. Carbon bonded to nylon will not flake, and is preferred. Stainless steel flakes and can contaminate the work place.

Factors to consider in using wrist straps are fit, (must be snug but not too tight), contact with the skin, life expectancy, and allergenic response of some wearers.

There are many good wrist straps on the market. Adjustable ones guarantee a good fit after many wearings and washings. There are also hypoallergenic straps available. (If a person is allergic even to those, you can put a floor mat down and have the person wear a heel strap, which doesn't have metal in it).

The straps must be tested regularly. At ISD this is done daily, and a test log is maintained. There are several wrist strap testers available that give results in seconds.

Caution: Since the person will be attached to ground, it is mandatory that a one megohm resistor be built into the wrist strap cord. If the person accidentally comes in contact with line voltage (115 Vac), the resistor will limit the current going through the body to a safe level.

Program Implementation

To have an effective ESD program you must have a dedicated ESD person in your facility. This person will be the one who learns all the details of the available equipment and materials, will be the one who attends the ESD conferences, knows the government specs, and is able to discuss ESD with your customers who are imposing their own ESD specifications on vendors.

This person must devote all of his time to the ESD program for at least the first nine to twelve months of the program. It will take at least that long for him to learn the necessary details. After that, ESD will occupy 50% or more of his typical work week. ESD questions are always coming up; new ESD materials and equipment are constantly brought onto the market.

At ISD the program was set up with representatives from Engineering, Reliability, Manufacturing, Facilities, Manufacturing Engineering, Product Assurance, Human Resources, Stockroom, and Purchasing. As the program evolved, the group was reduced to a small standing committee, headed by an ESD chairman from Manufacturing Operations. ISD also has two ESD technicians whose task it is to install and test equipment.

Every person in ISD has received ESD training in the form of a video tape presentation made in-house, and a handout that is reviewed with them by the trainer. Periodically ESD awareness bulletins are handed out.

ESD is an ongoing issue that is getting more important each year. Recognize and address it now.

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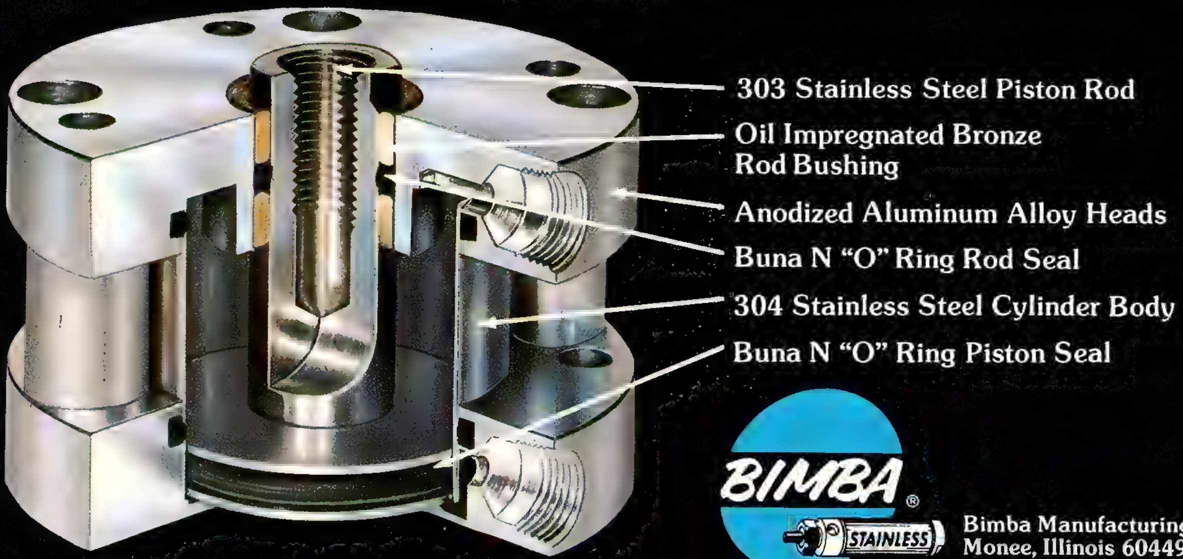
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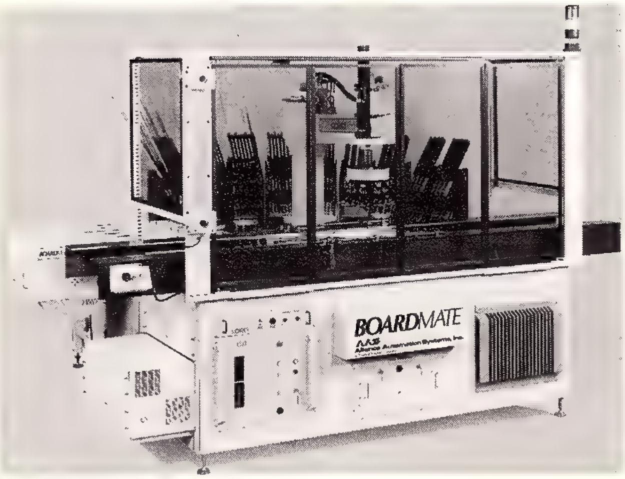

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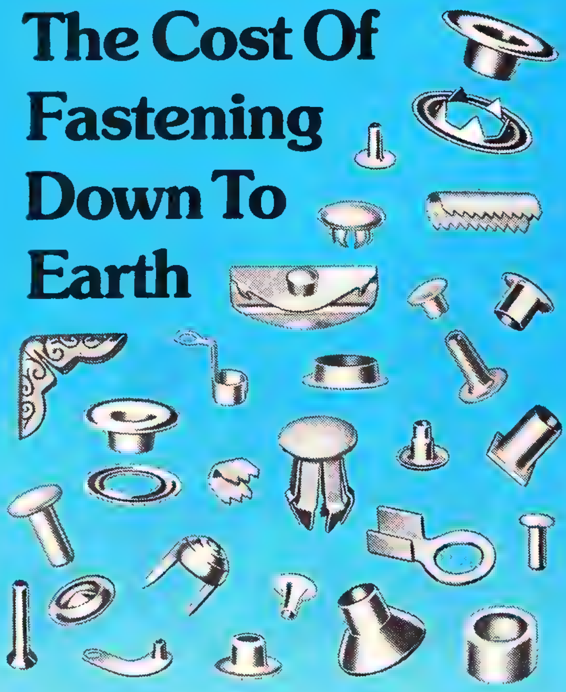

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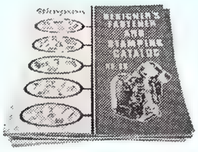

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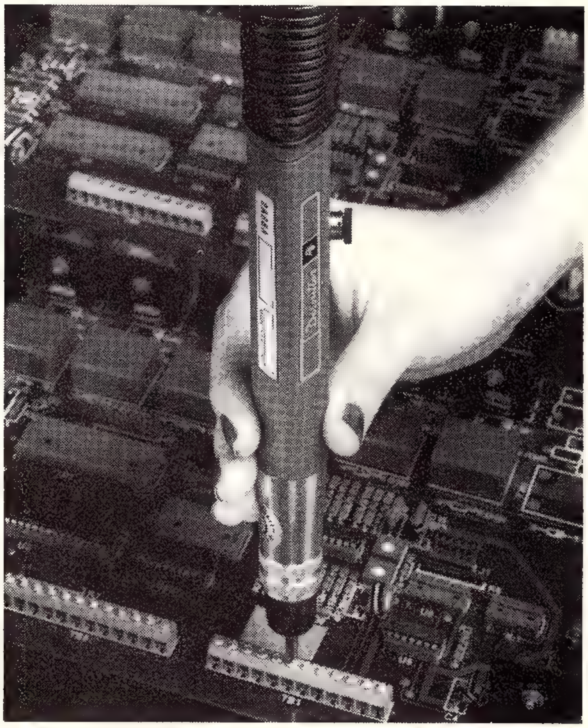

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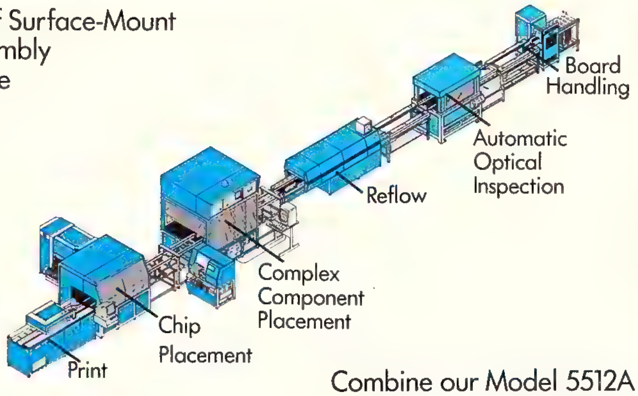

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High Density Electronics Packaging

Application Specific Integrated Circuits

Walter H. Schwartz
Senior Editor

The history of electronics packaging traces a pattern of increased functionality and decreased size in every product. One of the methods to reduce size has been to combine several components in one package. In the '30s Philco radios used multiple capacitor units potted in tar; in the '50s thick film resistor/capacitor units were used for interstage coupling and similar functions, and multifunction tubes were common. Then the integrated circuit was invented and the world of electronics assembly began to see what packaging density really meant.

Today very large scale integration (VLSI) ICs allow the consolidation of what a few years ago would have been an unbelievable number of functions into one piece of silicon. Yet the functions of available off-the-shelf ICs may not be optimum for a given application and designing a custom IC may be prohibitively expensive.

There are several alternatives to the use of a custom IC and there are other components in which functions have been consolidated in such a manner as to affect assembly processes and production test.

In less complex circuitry, programmable logic arrays permit the consolidation of several functions into one device. In many cases gate arrays are used in a similar manner. The result is lower assembly cost (usually not component cost) and smaller size.

In more complex circuitry, improved performance is the objective. Eliminating the pc board interconnects in favor of the very short paths within the IC allows much better high speed logic performance.

The standard cell approach in turn (allowing the mix of analog and digital devices, microprocessor cores, and all sorts of peripheral devices on one chip) permits greater consolidation of function and better performance.

Passive Component Arrays

Passive component networks present the simplest opportunity to eliminate discrete components and simplify assembly. Resistor networks and arrays are most common, followed distantly by resistor-capacitor networks and a few other components such as delay lines and filters.

Resistor networks are of two types, thick-film and thin-film. Thick-film resistors are screened by a process similar to that used to produce hybrid circuits. Thin-film resistors are produced by sputtering or vacuum evaporation. Thick-film resistors are available with values of from 3 ohms to several megohms. Thin-film resistors usually are more restricted in range. Values from 100 ohms to 100K ohms are common. Thick-film resistors have temperature coefficients of 300 ppm/°C or less and tolerances of 1 to 5%. Thin-film resistors have TCRs of 10 to 50 ppm and can be produced with tolerances as close as 0.01%. Thick-film resistors are low cost; thin-film units are relatively expensive.

Power dissipation of each element

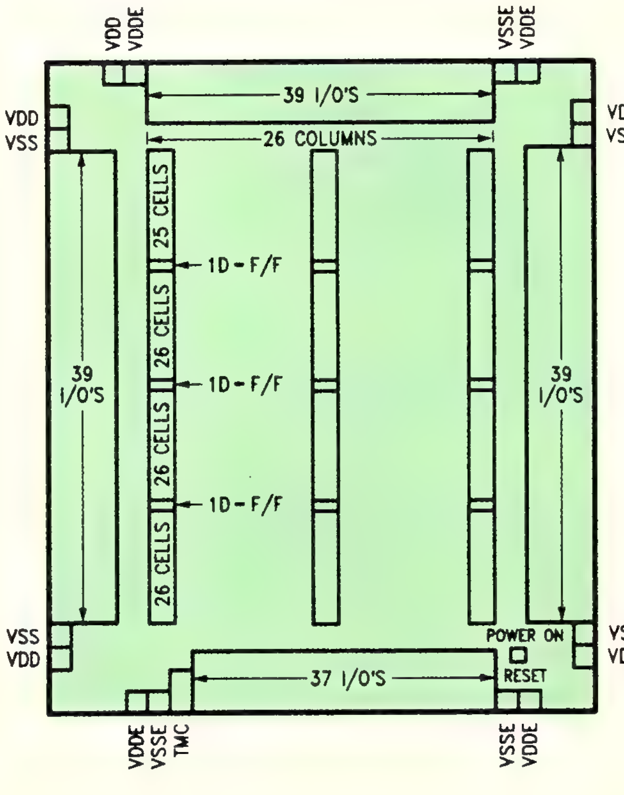


FIG. 1. *National Semiconductor's 6287 Die Structure comprises 2912 cells (26 columns X 112 rows), 702 gate equivalents as 78 dedicated D-flip-flops, 8034 general purpose gate equivalents, 8736 2-input NAND gate equivalents, 1 TMC pad, 155 input/output macro sites, 16 VDD/VSS power pads, 172 total available pads and 1 power-on-reset.*

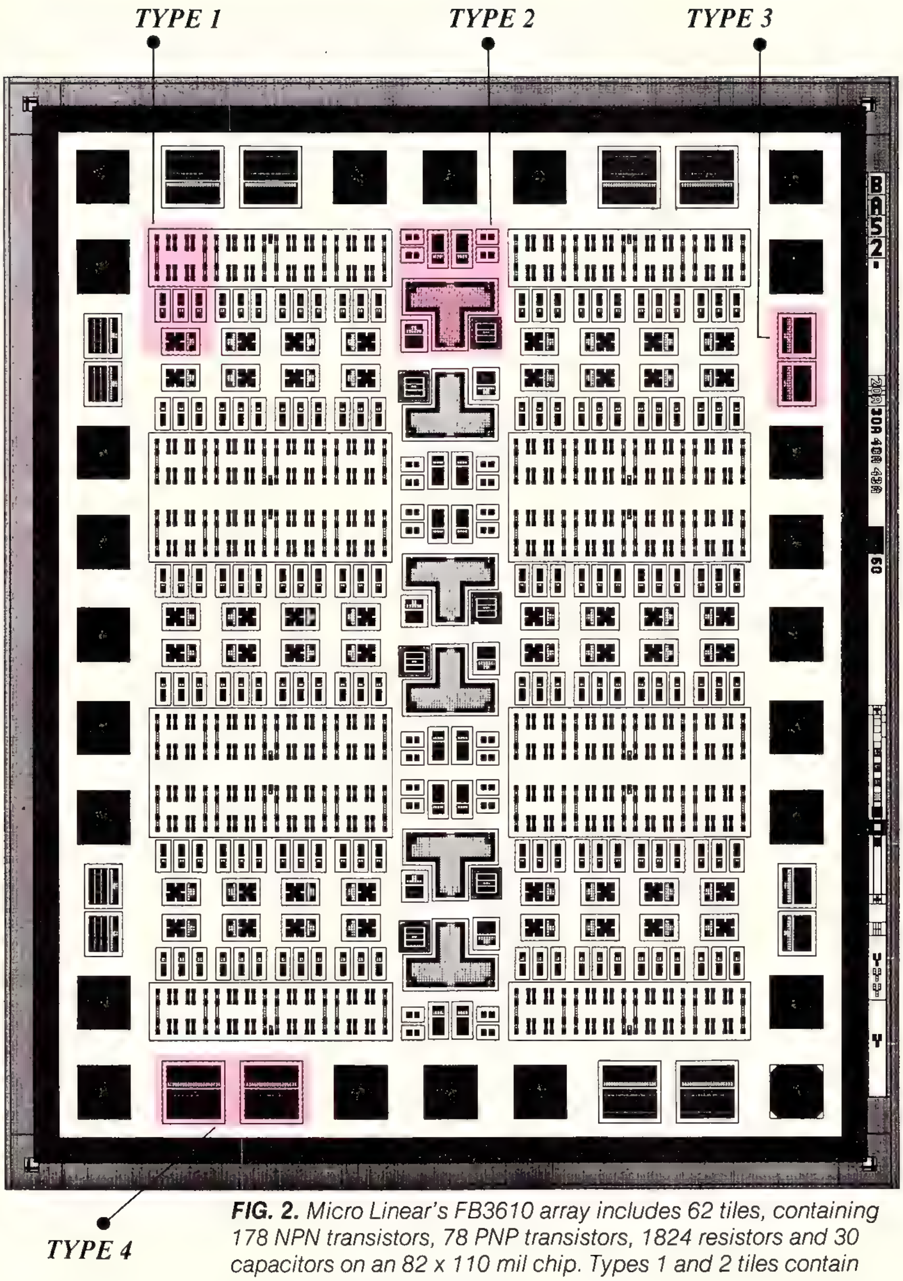


FIG. 2. *Micro Linear's FB3610 array includes 62 tiles, containing 178 NPN transistors, 78 PNP transistors, 1824 resistors and 30 capacitors on an 82 x 110 mil chip. Types 1 and 2 tiles contain simple transistors and resistors. Types 3 and 4 contain low noise and power transistors.*

in a thick-film network is typically 125 milliwatts, with some derating as the number of resistors in an array increases. Thin-film units are rated somewhat lower. Higher power thick-film networks with ratings of 250 mw per resistor are available in Japan.

Several packages are available in Japan, the most popular being the single-in-line package. In the U.S. the dual-in-line package is also common. In addition, small outline flat-pack and leadless chip carrier packages are available for surface mount.

Resistor-capacitor networks are available with a full range of resistor values; capacitor values range from 100 to 5000 pfd for zero temperature types and 500 pfd to 0.1 mfd for less stable types.

Programmable Logic Arrays

The least costly way to consolidate a number of logic functions in one piece of silicon is the programmable logic array (PLA). One such device may replace 4 to 10 standard chips with as many as several thousand equivalent gates, perhaps 5,000 in an extreme case.

As with the programmable read only memory (PROM) the PLA's functions are interconnected by fusable links, formed by diodes or the metallization pattern. During programming the undesired links are destroyed to form a pattern of function.

Programmable logic arrays are most commonly available in the various forms of transistor-transistor logic (TTL). They offer a relatively inexpensive off-the-shelf alternative to a number of discrete ICs. The programmer and the programming process do increase the cost. Formerly the desired logic had to be manually translated into fuse maps for programming. Today, new CAD tools make it possible to go from a truth table directly to fuse maps.

The Technology Research Group (TRG) predicts the PLA market will grow from about $350 million in 1986 to $1 billion in 1991, shared principally between TTL and complimentary metal oxide semiconductors (CMOS).

Gate Arrays

A gate array is an array of standard gates repeated time after time, capable of being interconnected by a custom metallization pattern into a great variety of combinations. Gate arrays may comprise anywhere from 500 to 10,000 or more, even 100,000 gates. The layout of the devices on the die is fixed by the vendor's original design. Customization is done through interconnecting metallization.

A typical gate array uses CMOS technology, with the following features, Figure 1:

- Available with 600 to 8000 or more gates
- Package pin counts to 172
- 95%+ typical utilization
- Oscillator micros for on chip oscillators
- Schmitt trigger inputs
- Output drive selectable for 1, 2, or 4 mA

Table 1. Analog cells available for 3μ SLM Technology

Cell Name	3μ SLM	Description
AMP	X	Amplifier, General Purpose
ANSW	X	Analog Switch
BGSTART	X	Band Gasp Start (used w/VRFPP)
CADC8	X	Converter, A to D , 8-Bit Input
CAP	X	Capacitor, General Purpose
CDAC81	X	Converter, D to A . 8-Bit Input
COMP	X	Comparator, General Purpose
COMPSS	X	Comparator, Special
COMP05	X	Comparator, Lo Power/Hi Speed
14UPD	X	Pad, Analog, Input
LLX	X	Level Changer, 0–5 V to −5 & +5 V
OPAMPM2	X	Op Amp, General Purpose
04UPD	X	Pad, Analog, Output
RES	X	Resistor, General Purpose
RESDIV	X	Resistor Divider Network, G.P.
VRFPP	X	Voltage Ref (used w/BGSTART)

Table 2. Special functions now available with 3μ SLM and 2μ DLM technologies.

Cell Name	3μ SLM	2μ DLM	Description
RAM	X	X	m-Words x n-Bits
m = 16 →	512	1024	(in increments of 16)
n = 1 →	8	32	(in increments of 1)
ROM	X	X	m-Words x n-Bits
m = 256 →	2048	8K	(in increment of 256)
n = 1 →	8	16	(in increment of 1)
PLA	X		128-Words x 4-Bits
CPU		X	68HC05 Microprocessor
CRTC		X	CRT Controller
EEPROM		X	Max size of 512 x 8

- Separate power supply traces for output drivers
- Outputs configurable as tri-state or non tri-state or open drain
- TTL and CMOS compatibility on both inputs and outputs
- Dedicated on chip test circuitry
- Several hundred different functions can be configured, each using as few as one to as many as 18 gates. Functions include gates, buffers, latches, flip-flops, multiplexers and demultiplexers, registers and counters, predrivers, oscillator macros, and a memory block.

In general, the array technique is not as often used with analog devices and circuitry. However, several companies such as Micro Linear Corp., San Jose, and Custom Arrays, Sunnyvale, CA, do offer general purpose analog arrays. These are based upon cells (Micro Linear calls them tiles), which in turn comprise the array chip. These arrays include resistors and capacitors as well as a variety of transistor types.

In the Micro Linear arrays eight different types of tiles offer different capabilities, Figure 2. For example, T1 and T2 types contain general purpose components, transistors and resistors and a silicon dioxide capacitor, while other tiles contain more specialized low noise, high frequency or power transistors, high-value resistors and precision matched resistors. Micro Linear uses a two layer metallization to interconnect components on the die; no dedicated routing channels are needed.

Using one or more tiles allows configuring circuits such as precision voltage references, op-amps, comparators, video amplifiers, modulators/demodulators, IF/RF amplifiers, timers, and digital to analog converters. In addition several TTL style digital devices can be implemented.

The gate array approach to ASICs is currently dominant. Since the unique processing steps required for a gate array are only those concerned with metallization, the cost is much lower than that of standard cell-based ASICs even at relatively low volumes.

Gate arrays are predicted to reach a volume of $3.6 billion by 1991 compared to $1.9 billion in 1986. The bulk of this will be CMOS although the use of analog (linear) arrays will increase.

Standard Cells

The most versatile means to develop semicustom integrated circuits is by using standard cells. Each is a proven design performing a specific function. The user can select from a library of such cells those that fulfill his needs and assemble them to be processed on a silicon wafer. Unlike the gate array, where the silicon wafer has already been processed to where it only needs metallization, the standard cell is only a standardized design.

The vendor's standard cell library, often based upon its standard products, can contain both analog and digital circuits.

As an example, Motorola now offers two Standard Cell Libraries: one uses 3 micron single-layer metal technology; the other 2-micron double-layer-metal technology. The 3-micron library originally offered more analog functions and passive components, while the 2-micron library offers large complex core functions such as a microprocessor. Both offer RAM and ROM and a variety of logic functions such as gates, buffers, etc. (See tables 1 and 2.)

While the design of each cell is from a standard library, each overall mask is unique, and all processing steps must be performed, making both cost and lead time greater than for gate arrays. The economical volume necessary is substantially greater. Engineering costs are being reduced; the cell-based IC is the fastest growing segment of the ASIC market. TRG predicts a $5.8 billion market by 1991 compared to $443 million in 1986. By that time they will outsell gate arrays by a considerable margin.

ASIC Design

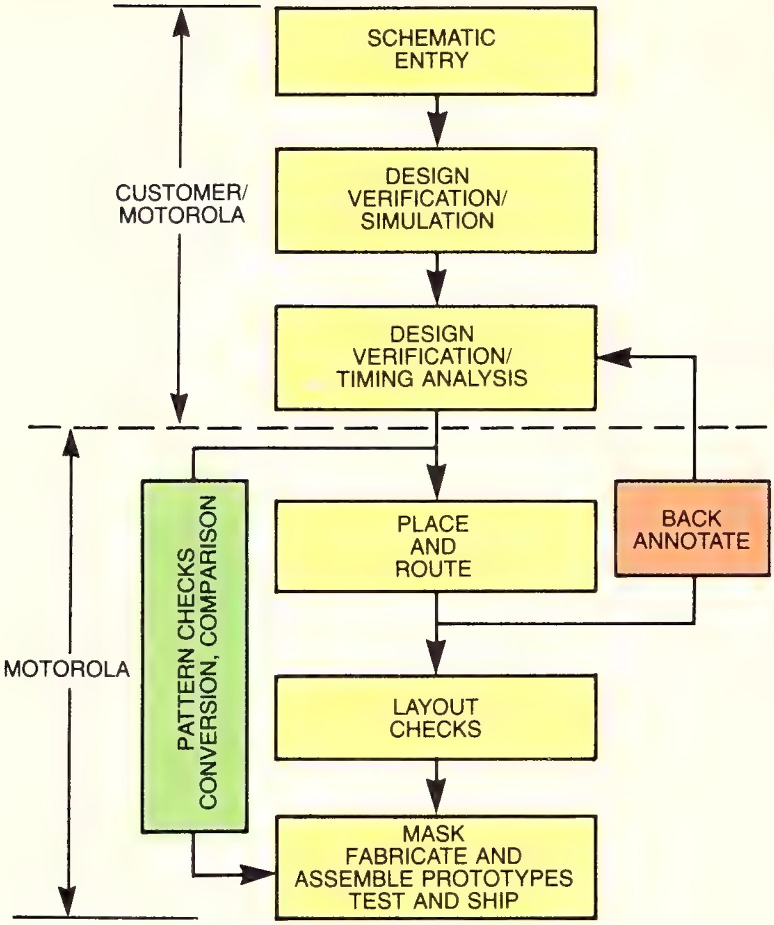
Most ASIC vendors have design centers at strategic locations around the country, even around the world. These offer the customer CAE tools and the staff necessary to support them. In some cases customers are able to directly link their own in-house CAE systems to those of the vendor. In other cases software packages are available, for IBM AT compatible personal computers for example, which allow the user to do complete design in-house. Custom Arrays, in fact, can produce masks from customer supplied data on 5 1/4 in. floppy discs (and, it is claimed, produce prototype ICs in as little as five days). Software improvements are making design easier and more affordable.

Some time ago a TRG study showed 15% of the designs done by the vendors, 6% by distributors and consultants, 10% by customers on their own CAE equipment and 69% designed on vendor CAE systems, involving both vendor and customer.

Vendors can offer support from full turnkey delivery of an ASIC to simple monitoring of a customer's development process. Regardless of who does the design, in most cases the process will follow a certain pattern.

The circuit is first defined; the functions to be integrated are determined. Partition analysis then determines the best way to divide the system into simpler blocks. A functional simulation next verifies operation.

The designer then selects appropriate standard cells from the vendor's library; layout is determined, simulated and analyzed. The masks are generated and devices are produced and tested, Figure 3.


SCHEMATIC ENTRY
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DESIGN VERIFICATION/ SIMULATION
DESIGN VERIFICATION/ TIMING ANALYSIS
MOTOROLA
PATTERN CHECKS CONVERSION, COMPARISON
PLACE AND ROUTE
BACK ANNOTATE
LAYOUT CHECKS
MASK FABRICATE AND ASSEMBLE PROTOTYPES TEST AND SHIP

FIG. 3. *Motorola's ASIC development process is similar to other vendors. Design automation tools available to customers encompass silicon generation/compilation, timing analysis and design verification, layout analysis and test generation. Motorola provides turnkey as well as interactive development procedures. For interactive designs the customer enters logic schematic and simulates the design on engineering workstations. Daisy, Mentor Graphics and Valid are fully supported. Motorola then commences with place and route.*

Costs

What can the relative cost of semicustom or application specific integrated circuits be? Too many factors must be considered to allow a general answer. Depending upon the technology, CMOS is lowest cost, bipolar and mixed technologies are more expensive, gate arrays can cost as little as 0.1 to 0.3 cents per gate for low density, low cost package units at production rates of 100,000/yr. Higher power, higher density, high reliability packaging can push the cost to over 1 cent per gate.

Assembly Problems

John Carey of Motorola Semiconductor Products, Application Specific Integrated Circuit Division, suggests semicustom ICs can reduce the board count of a complex system by a factor of three as compared to the use of commodity logic chips.

To assembly this means fewer, smaller pc boards, smaller, closer spaced pc board traces and pads, fewer packages to place and closer spaced (but not necessarily fewer) pins to position.

This in turn means a need for greater precision in component insertion and in surface mount solder paste deposition and component placement. At the same time the absolute number of interconnects, solder joints, will be reduced, resulting in a reduced likelihood of defects and greater product reliability.

Denser packaging means thermal management problems; heat sinks may be needed on some ICs, thus requiring another assembly step.

Unless test points are designed into the pc board pattern, production test may be impossible. Component spacing is very close, and in the case of surface mount ICs, pads may be underneath. Accessible pads must be available by design.

This close spacing, concealed solder joints, and small traces and spaces make visual inspection equally difficult.

And when manufacturing defects and defective components are found, rework is difficult at best. It may be impossible to directly apply heat to solder joints under ICs. General area heating may reflow good solder joints attaching good components, producing the possibility of new defects.

These factors present new challenges to the manufacturing engineer and more than ever require close cooperation between design and manufacturing.

The following companies have contributed information to this article. For more information, Circle Number:

Custom Arrays Corp.	**10**
Motorola, Inc.	**11**
National Semiconductor Corp.	**12**
Micro Linear Corp.	**13**

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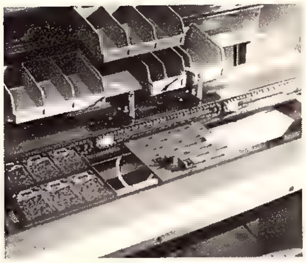
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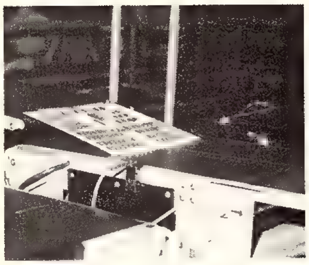
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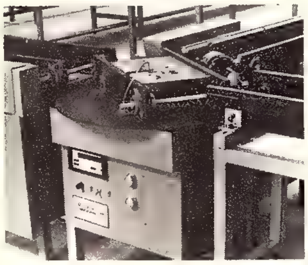
overhead carrier return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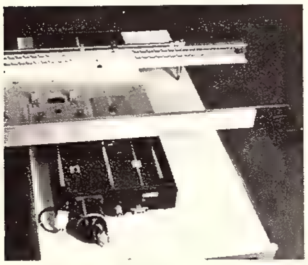
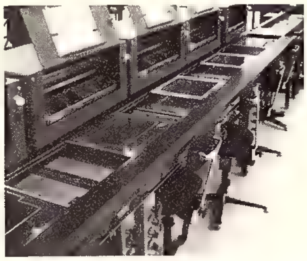
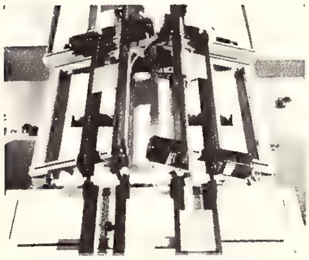
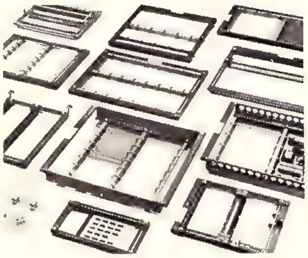

303-SLU shuttle conveyor

palletless assembly conveyor

double slide line assembly conveyor


303-PF positioning float assembly conveyor


15° tilt to 0° offload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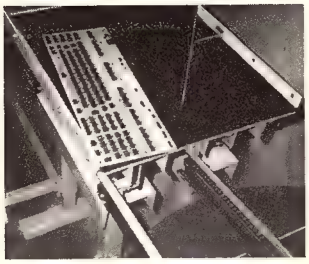
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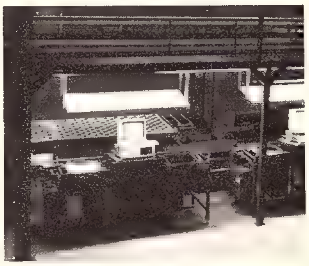
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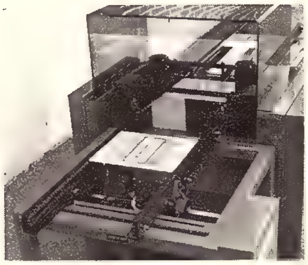
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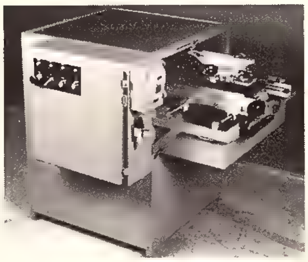
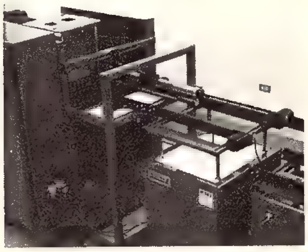

bare board loader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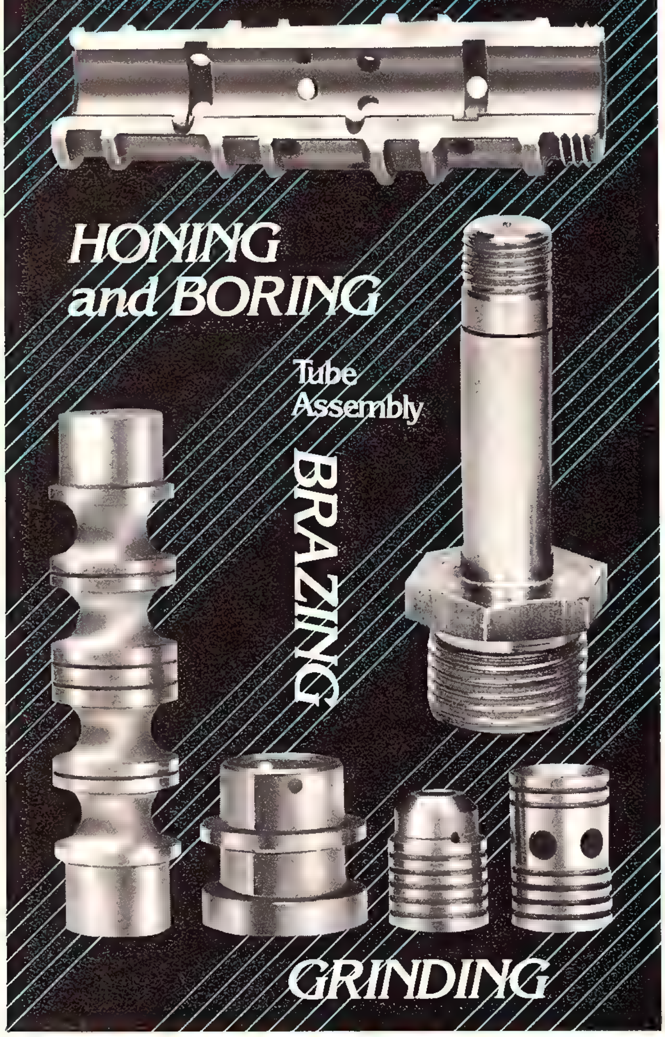

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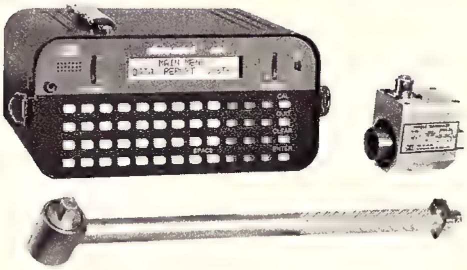

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Electronics Connector Update

To a great extent connector manufacturing is a mature industry. Nevertheless, new demands are being presented in the areas of density and high-frequency performance and research continues into contact materials and forces and new body materials. Such problems were among those discussed at the Electronic Connector Study Group's 20th Annual Symposium held recently.

To make insertion and withdrawal forces of high pin count connectors manageable, it is necessary to minimize the insertion force of individual pins while maintaining adequate force for reliable contact. Lubricants may also be useful (see sidebar).

Withdrawal force is often considered to be related directly to normal force (i.e., the force acting perpendicular to the contact surfaces, which has a major bearing on contact resistance); Max Peel of Contech Research insists this is a myth. Withdrawal force, he feels, is too dependent on coefficient of friction, or finish, roughness, cleanliness, and lubrication to allow more than a guess when related to normal forces. Normal force is rarely documented; its specification should be required of vendors.

Whitley and Mroczkowski (Amp Inc.) found the normal force on properly designed gold plated contacts can be much lower than the 100 grams of the traditional minimum. Contact resistance of 2 milliohms is possible with a normal force of 25 grams.

Another approach to low insertion force miniature connectors is Amphenol/Bendix Connector Operations brush contact design. This contact, with a current rating of 2 amperes, comprises a bundle of strands of gold plated wire in a specially designed retention sleeve that allows 0.075 in contact spacing and a contact total of 300 or more per connector. At 1.5 oz mating force, it has a durability of at least 20,000 cycles of mating and unmating.

Surface mount connectors present their own special problems. The many leads of a multipin connector all must contact the board at the same time (coplanarity); no gaps should exist. It is difficult to screen sufficient paste onto the board to fill the gap. Leka Interconnects offers a series of surface mount connectors that incorporate a solder preform crimped onto the lead where it contacts the pc board. This supplies sufficient additional solder paste for a proper joint.

Contact materials used in high current connectors are selfheating because of their resistance. Copper is both a good electrical conductor and a good heat conductor. Unfortunately it is too soft to be an acceptable connector material. Murty, Simonsen, and Taniguchi (NGK Metals Corp.) have explored the use of beryllium-copper alloys.

Heat generation in a material is re-

CONNECTOR LUBRICANTS

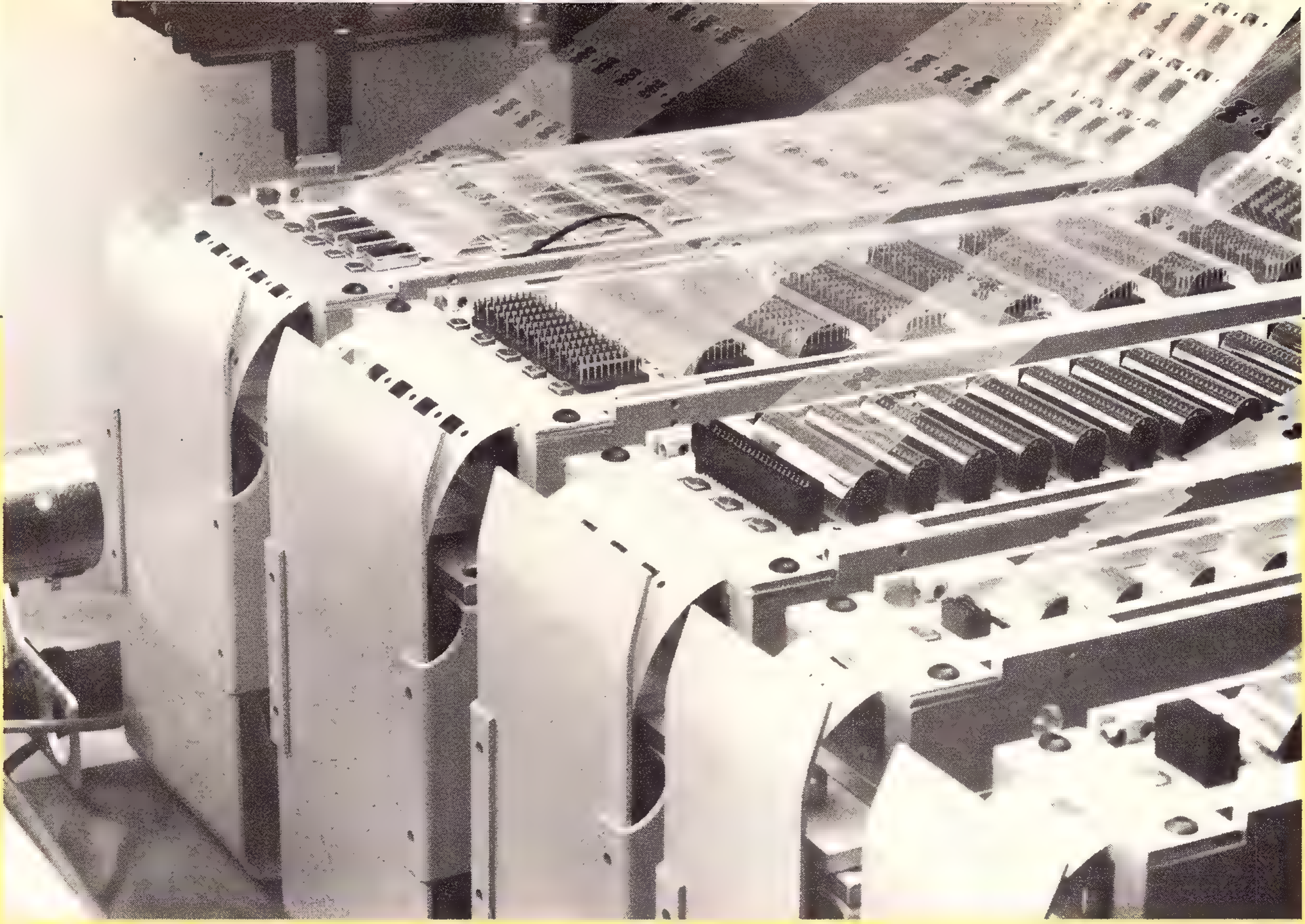
Advances in electronics have created demands for increased performance in connector lubricants, says David McCollum, senior research engineer, Monsanto Chemical Co. Up to 300 pins may now be required in connectors. Some connectors are becoming so large that they can not be assembled without lubrication.

The use of electronic equipment outdoors has also increased performance demands for lubricants. Electronics equipment is now exposed to more severe environments than ever before.

There are three basic reasons for lubricating connectors. First, good lubrication can dramatically increase the life of connectors that are prone to galling and excessive wear during mating cycles. Second, they prevent corrosion in harsh environments. Even in moderate environments, gold-plated alloys used in connectors are subject to corrosion caused by moisture. Third, lubricants reduce the insertion forces that are increased by high pin counts. Most design requirements call for low overall insertion force.

Monsanto offers a six-ring polyphenyl ether lubricant, OS-138 with an operating temperature as high as 230°F, developed in response to a request from AT&T for its telephone switching equipment.

Polyphenyl ether lubricants not only offer increased temperature capabilities, but once applied during manufacturing, they remain on the surface and continue to perform for thousands of cycles and years of service. Other silicon and petroleum lubricants last only about 10 mating/unmating cycles. For more information, **CIRCLE 28.**



ODD-FORM COMPONENT FEEDING

GPAX component feeding for the robotic workcell combines a continuous tape package with a compact, flexible feeder. In GPAX packaging the component is located on a carrier tape using a pattern of punched holes that maintains its position within 0.001 in. Bonding tape holds the component in place. Once the tape is assembled with components, it is wound onto a reel, using foam interleave for cushioning.

On-line, the contents of the tape package are presented to a robot using a dispenser that releases the bonding tape, and serially presents the components, accurately located and properly oriented, to the robot.

To maximize on-line inventory, smaller components can be packaged in multiple rows on wider tape. A 4.5 in. wide tape with 14 components per row would have 10,000 components per reel. GPAX dispensers can be mounted close together, and average dispenser width is only 4.5 in. when mounted, providing the maximum number of parts per station. For more information, **CIRCLE 29.**

lated to its specific resistance, specific heat, and thermal mass. Of the materials considered, pure copper offers the least response to temperature rise, followed by CrCu, BeCu 10 and 14 alloys, red brass, BeCu 25 and 165 alloys, 510 phosphor bronze, etc. The BeCu alloys exhibit good electrical and mechanical characteristics. They offer a balance between strength, self heat generation, spring properties, and formability.

Quinn, Bailey, Wolverton, and O'Brien (LPN Corp.) discussed high temperature thermoplastic composites performance at over 500°F. Polyethersulfone (PES), polyetherimide (PEI), high temperature amorphous polymer (HTA), polyetheretherketone (PEEK), polyphenylene sulfide (PPS), and polyfluoroalkoxy copolymer (PFA) base resins were studied with glass- and carbon-fiber reinforcements.

PES, PEI, and HTA, amorphous resins, generally offer better performance in the 300-400°F range. Chrystaline composites, PEEK, PPS, and PFA offer greater strength above 350°F. Insulative glass composites are suitable for connectors, etc. Carbon reinforced composites are conductive and are used for housings and shielding.

For more information on the products or techniques mentioned in this article, Circle Number:

Contech	20
Amp	21
Amphenol/Bendix	22
Teka International	23
NGK	24
GE Plastics	25
LPN Corp.	26

Walczak and Richards of GE Plastics presented data on polybutylene terephthalate (PBT), polyethylene tetraphthalate (PET), and polycyclohexane dimethylene tetraphtalate (PCT). They pointed out that glass fiber may cause nonuniform mechanical characteristics and material warpage. Properties will be better in the direction of flow because of the parallel orientation of fibers; thermal expansion will be lower, and strength greater. This is important when mating connectors with connectors or pc boards.

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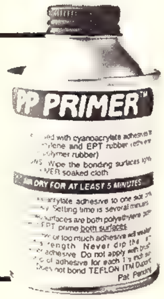

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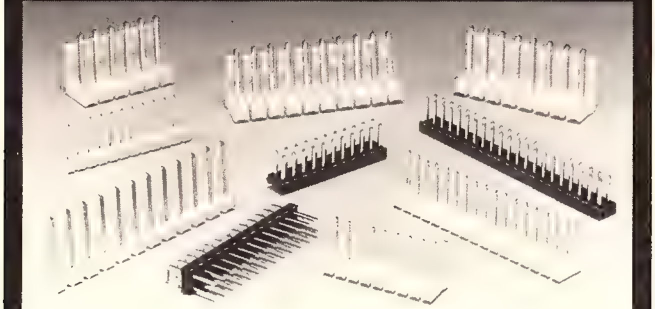

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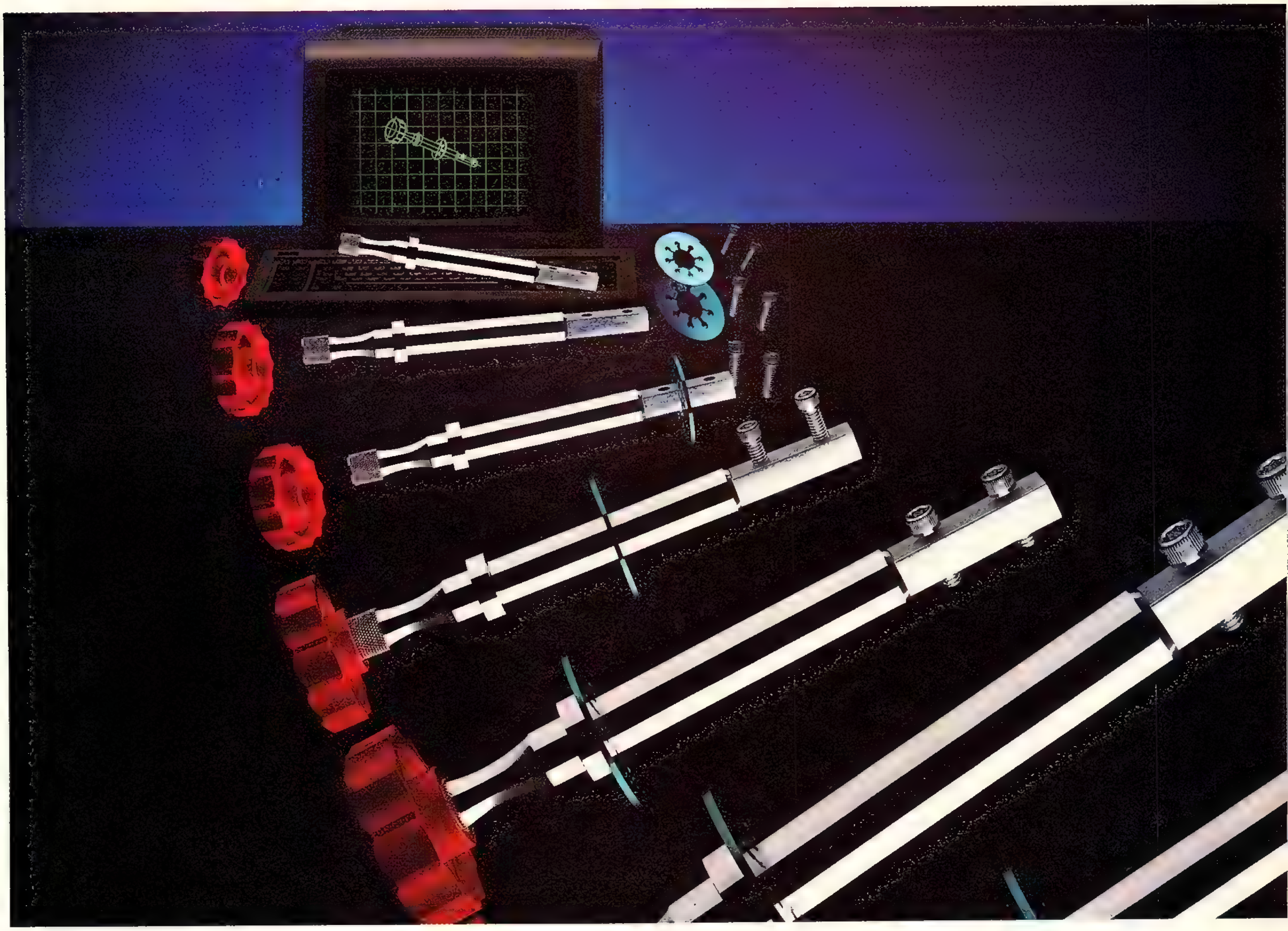

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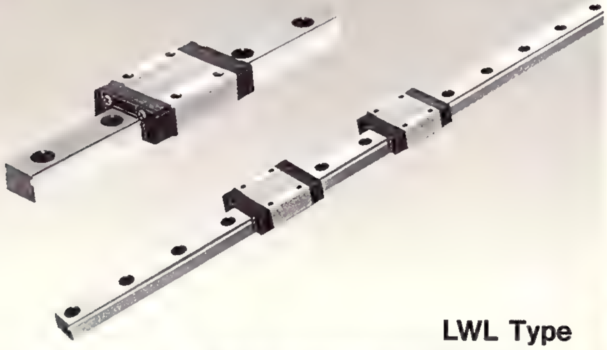

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LINEAR WAY

LWA Type
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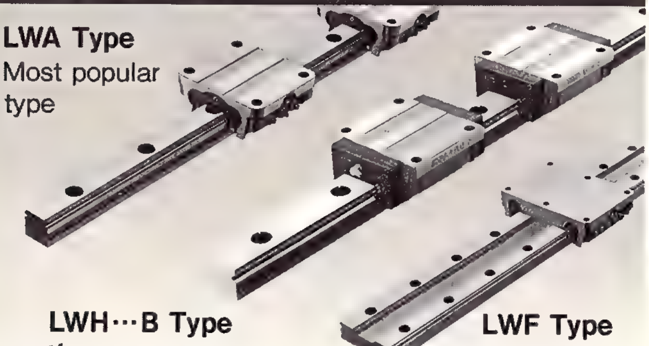

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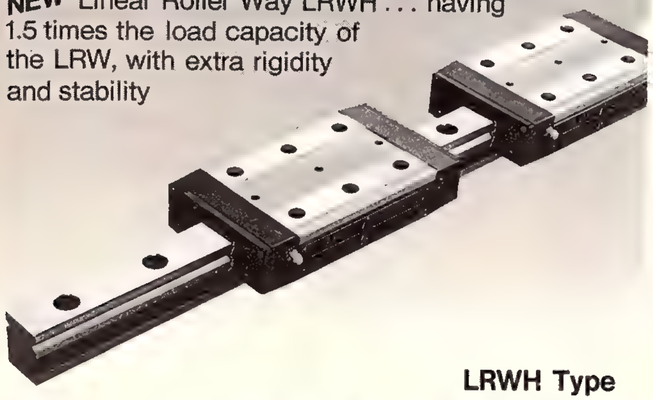
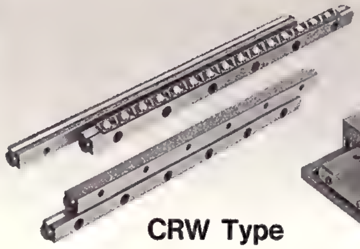
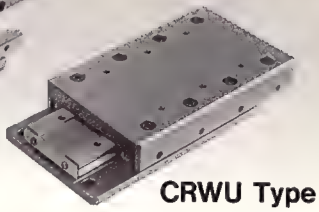


LRWH Type

CROSSED ROLLER WAY



CRW Type



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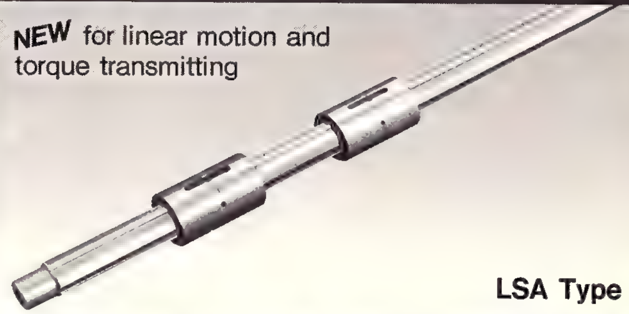

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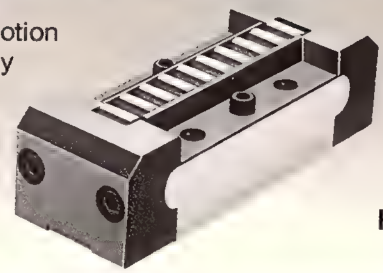

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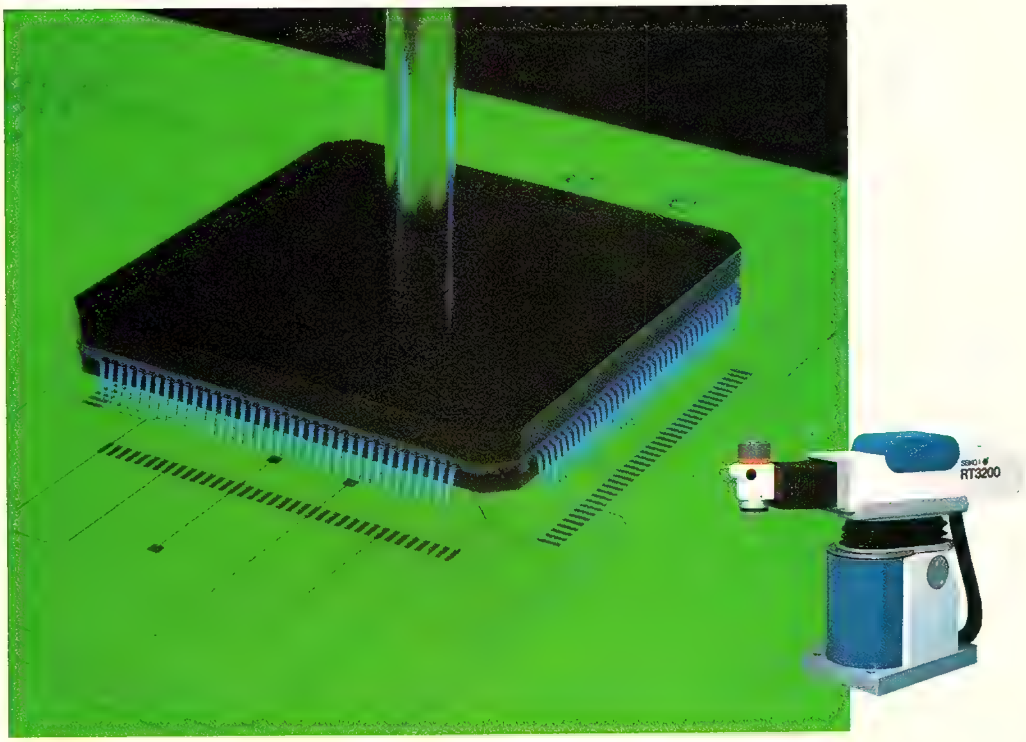

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* Rework costs are a function of individual corporate accounting practices. Best industry sources rate rework and repair costs at 6 to 10 times the cost of a correct initial assembly. One well known study concludes that if it costs $1 to find a component failure, it costs $10 to make a board level correction, $100 to correct a final assembly, and $1000 for a field repair. Should a board level assembly mistake reach the field, the mistake might well cost 100 times or more of the original assembly cost to rework or repair.

PLASTIC FASTENERS FOR ELECTRONIC ASSEMBLY

What Are My Options?

Michael G. Whitney
Applications Engineer
ITW Fastex

One of the biggest uses of plastics in the electronics industry is for fastening and retaining components. Plastic fasteners can reduce assembly weight, while providing adequate support and retention without sacrificing impact and shear strength. Such fasteners can be used for localized insulation, and some metal-filled grades are even good for EMI/RFI shielding. Other grades, especially thermoplastic elastomers, are being used for extreme vibration and shock absorption.

Moreover, plastic fasteners can be made with a variety of surface finishes and custom and matched colors. Component color coding simplifies mass assembly as well.

Know the Need

Electronic equipment has several distinct areas for fastening, each with its own requirements:

- Housings and shells require structural strength and integrity from fasteners, whereas printed circuit boards need proper support and vibration resistance.
- Switches, displays, and indicators often are mounted in cosmetically important holders; large power components and transformers are attached in the most convenient way available.
- Wires and cables require orderly routing and management to avoid servicing nuisance and interference with other components.

These examples highlight the need for specially designed fasteners bringing maximum function to specific application.

The main consideration in choosing a fastener for electronic assembly is cost effectiveness. Other factors, though, are important in making the final determination, e.g., mechanical and thermal performance, insulation or grounding requirements, etc. Cost of repair and servicing also must be analyzed (i.e., will the specified fastener allow adequate accessibility).

Compliance with applicable agency standards (UL, CSA, TUV, and VDE) can be required of fasteners in most consumer electrical products. The ability to resist corrosion and electrolysis, and meet conductive and magnetic requirements, also plays a role.

The fasteners most often used in the electronics industry can be divided into four groups: panel fasteners, wire management products, electronic components, and products developed for specific needs.

Panel Fasteners

Drive Pin Rivets. These plastic fasteners are used for strong, reliable joining of two or more thin wall panels. A broad selection of Plasti-Rivets® is available including specials. Plasti-Lok™ rivets are ideal for extreme vibration environments because two tabs lock in place when inserted. There also are removable rivets with threaded pins that are driven in but can be unscrewed. Threaded rivets are intended to hold securely in through holes, or, in certain materials, blind holes. As the pin is driven, external threads bite into the wood or particle board panel providing a tight grip.

Snap-In Fasteners. Ideal for connecting both rigid and compressible materials, one approach called a Ratchet Rivet requires two mating parts that rachet together and provide variable take up. Another example is a Canoe Clip®, a low cost replacement for screws and rivets that snaps securely into round holes and is intended for light duty use. The body is shaped like a dugout canoe. It compresses as it passes through the panels, then returns to original shape. A similar product (Stalok™)

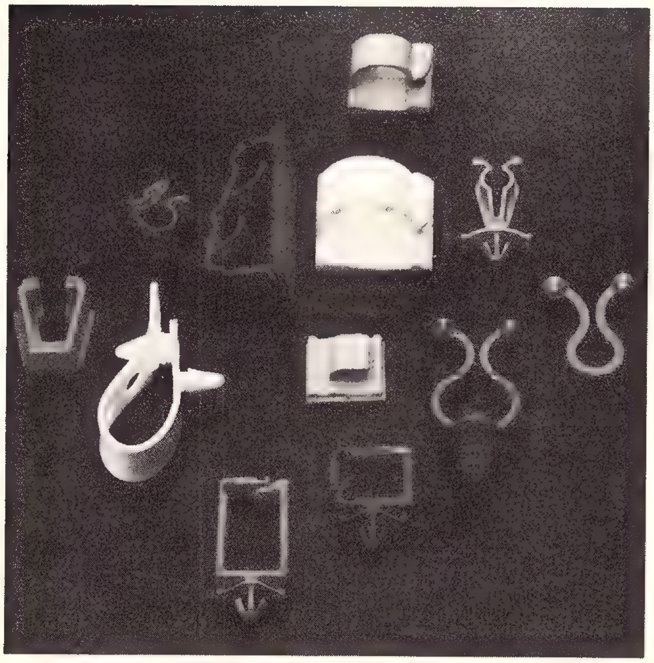

FIGURE 1. *Various snap-in clips and wire routing devices. Depending on the configuration, wires can be inserted into a clip either before or after the part is inserted in the panel hole. Some styles even provide desired spacing away from panels or other parts. ITW Fastex*

provides tamper resistance since it cannot be removed from the outside.

An extremely versatile fastener is the Christmas Tree Clip™, which has a ribbed shank for fast, easy installation and secure holding in a range of materials. The ribs deflect as the part is pushed into place, springing back as they pass through the hole. This shank section is incorporated in a variety of other parts often used in blind-hole application.

Screw Grommets. For many reasons, screws may provide a distinct advantage in panel fastening. Plasti-Grommets™ are screw receptacles that spread loads over a larger area, insulate at fastening points, eliminate cross threading, and protect against electrolytic action. Encloz® screw grommets fully encapsulate metal screws, providing electrical insulation and protection against temperature and moisture transfer and exposed screw points. A reversed version can be used for fastening from the panel's opposite side.

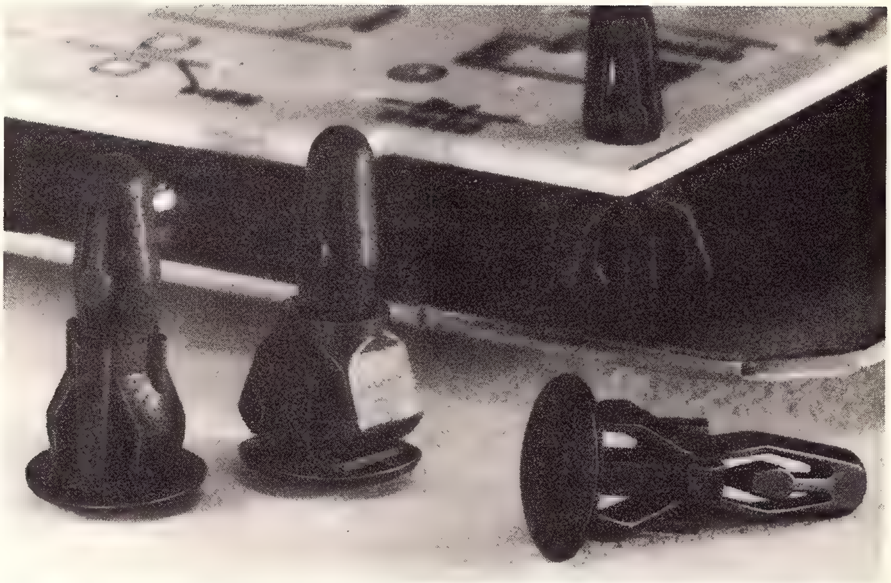

FIGURE 2. *Reverse PCB support. The part snaps into a square hole in the chassis from the outside and provides proper spacing for the board, which is mounted from the inside. No tools are necessary to install the fastener. Further, screws which could work free from cracked support clips and cause shorting are obviated. The new plastic reverse PCB support is molded in special colors to match the computer bases.*
ITW Fastex

Wire Management

Adhesive Backed Cord Clips. These products provide a fast, efficient way to organize wire, cords, and cables. Paper backing is removed and parts are applied to any smooth, clean, hard surface including wood, plastic, and metal. A variety of sizes and styles accommodate most cable and bundle sizes, which are slipped in and retained securely.

Snap-In Clips. When more positive mechanical fastening of wires to a panel is required, these clips provide it through a variety of shapes and styles, Figure 1.

Flat Cable Clips. Up to 60 conductor flat cables can be accommodated in both adhesive backed or snap-in type flat cable clips. Smaller cables can be controlled in other versions, including one with a tab for an optional screw.

Wire Ties. Unlike conventional wire ties, Purse Lock™ ties can be opened for adding or removing wires and then reclosed. This product twists and interlocks the tie ends enclosing the wires. Sizes are available to accommodate a range of bundle sizes. The Standoff Purse Lock™ routes wires and cords while holding them away from panels or moving parts.

Strain Relief Grommets. These one-piece units snap easily into a panel hole to protect cord from pullout forces. Two styles accommodate many standard wires, prevent abrasion, and eliminate cord contact with the panel.

Electronic Components

Circuit Board Supports. A variety of PCB supports and spacers are available to accommodate most serviceability and mounting requirements, with many standoff heights and fastening options. Edgemount supports feature a flexible tab, thus allowing quick release for easy board maintenance. One style, fitted with a Christmas Tree shank, is ideal for use in particle board or wood cabinets. When space is at a premium, mini pc board supports can be used in smaller diameter mounting holes. Several support styles are designed for reverse mounting with only a low profile button head exposed for view.

Card Guides. Both horizontal and vertical versions keep boards in place yet allow quick insertion and removal for installation, repair, or replacement. They are for mounting a board parallel to the chassis or in tandem with another board.

LED Holders. These one-piece retainers snap into either flush or counterbored holes providing secure, attractive display of standard LEDs. No additional retaining rings or special installation tools are necessary.

Products for Specifics

Many of these fastening options were created to solve a specific fastening or mounting problem. Product lines with broad applicability grew from them. Standard catalog items normally ensure the most cost efficient fastening approach, but design specialization of electronic assemblies often demands equally novel approaches in fasteners. Here are some examples:

Reverse PCB support. A major manufacturer of sophisticated per-

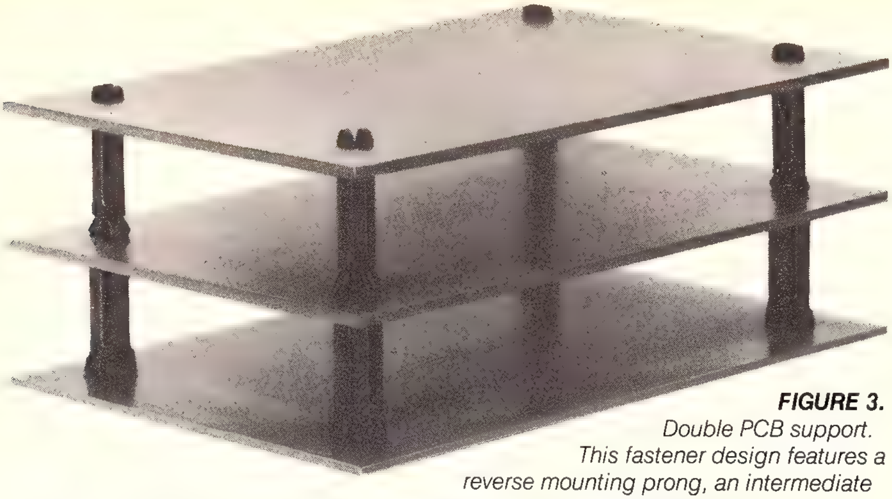

FIGURE 3. *Double PCB support. This fastener design features a reverse mounting prong, an intermediate prong to hold the first board, and a low profile end prong to hold the second board. The fastener, though long and thin, has adequate strength to hold support boards from a cantilever position. Installation requires only snapping the standoff into the cover plate, and the two boards (in sequence) onto the standoff. ITW Fastex*

sonal computing products was experiencing production problems with fasteners inside its computers. The fastener, a two-piece pc board support consisting of a plastic clip and anchoring screw was labor intensive to install. It required fixturing the plastic support so the screw could be turned. Over torquing could strip or even break the support clip, and slippage during assembly would scratch the computer base. The solution was a one-piece, nonconductive plastic fastener with a low-profile, button-type head, Figure 2.

Double PCB Support. A large scale manufacturer of communications equipment that was developing a logic module assembly; however, there were several difficult mechanical design challenges. One pc board was to be vertically mounted behind the assembly cover, with a second board mounted directly behind the first. Depth and surface space were at a premium, proper positioning was crucial, and quick easy assembly was necessary for cost control. Mounting these boards by conventional means required too much space and time, and more fasteners than desired. A one-piece PCB support was developed to hold all three panels using mounting holes in each on the same center lines as the others, Figure 3.

Three Bulb LED Holder. This final example highlights a design project involving a special LED holder. Three rectangular LEDs required mounting to a pc board, with precise center spacing between the three bulbs, maintenance of a specified height from the board, and compatibility with automated insertion equipment.

The first step was to select a material that had good dimensional stability (even at elevated temperatures), with no warping or skewing after molding. The material chosen also had fairly good spring action and easy molding, which contributed to lower processing costs. The fastener was designed with an open configuration to accommodate pick-and-place robots used for installation, Figure 4.

Because the LEDs were premounted in the holder before being installed on the board, guide channels were included to direct the leads down into the base. Holding the LEDs in position was not simple, as bulb shoulder thickness was generally inconsistent. Flexible "fingers" were designed to continuously force the LEDs upward against the top shoulder to ensure a controlled height above the board.

Tieing Everything Up

Fastening and joining can be extremely troublesome, especially to manufacturing engineers dealing with electronics assembly. Fastening can contribute as much as 30% to a product's cost. Innovation in plastic fasteners, however, has created many cost-effective options.

Improved temperature and humidity resistance, impact strength, dielectric strength, and chemical resistance—with little or no sacrifice of other design parameters—make the choices attractive. And there are almost an unlimited variety of shapes, sizes, and finishes available.

The advances in surface mount technology, improved circuitry, use of polymer thick film, etc., have put a corresponding demand on fastener performance. Material suppliers will be pressured to provide still better grades of plastics at lower prices, and fasteners will be reduced in both size and number, thus requiring even better performance. And automated assembly will certainly dictate new styles and shapes specifically geared to machine insertion.

For more information, **circle 4.**

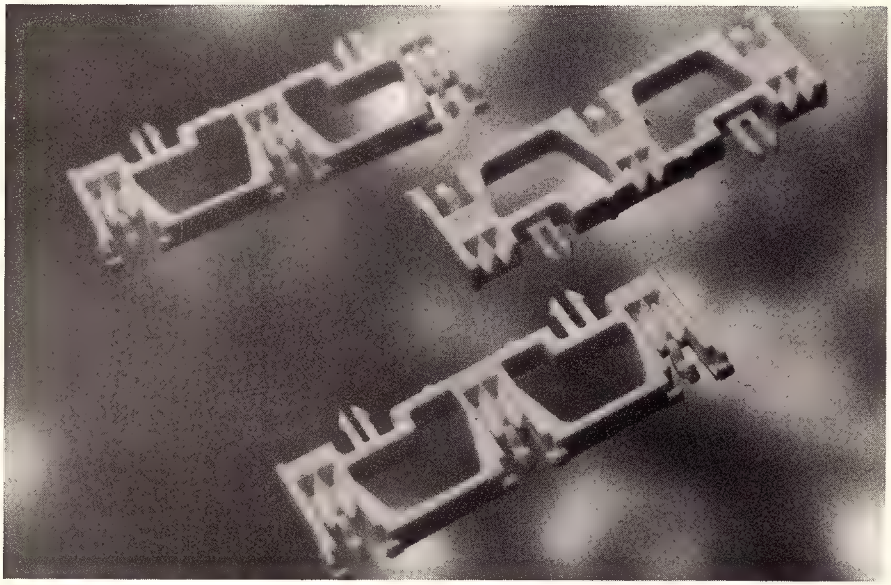

FIGURE 4. *Three bulb LED holder. The two mounting prongs on the base are of unequal size to ensure that the retainer can't be inserted backwards, reversing the polarity of the LED leads. Feet or risers are located on the base to lift the retainer off the pc board, allowing cleaning solvents to wash over the board after soldering. ITW Fastex*

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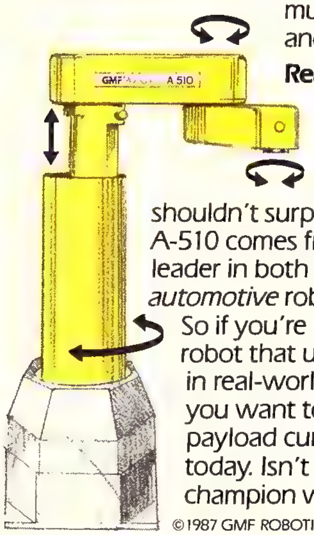

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One Smart Assembly System

Much of the brainpower at GE's refrigerator assembly plant is supplied by a SMART (Shop MAnagement Recording and Tracking) system. Designed by GE Fanuc Automation North America Inc., the system provides information to help make GE's top-mount, no-frost refrigerators.

SMART oversees an automated subassembly area, two final assembly lines, supporting fabrication machines, and several overhead conveyor systems. The system monitors and displays the status of the manufacturing process by looking at 5000 information points residing within 70 GE Fanuc Series Six programmable logic controllers (PLCs) in the plant. Information gathered from the PLCs includes production counts, uptime, station cycle times, machine malfunctions, and diagnostics. Using this information, the system spots problems and sends alarms to appropriate personnel.

SMART includes a subsystem called SQC/SPC, which monitors quality-oriented data either from the process—characteristics such as temperatures, pressures, or cycle times—or dimensions, or other product characteristics. Data can be displayed as tables, Pareto charts, histograms, or SPC charts. For example, final product testing is heavily monitored; 30 electrical tests are performed and SMART provides control charts for all variables coming out of those tests.

GE's refrigerator plant features a Shop MAnagement Recording and Tracking (SMART) system. Using it, an engineer gathers data about the assembly line in the background.

The system can transmit schedules to monitored machines and assembly lines. Then it tracks production against those schedules and coordinates assembly line changeover. An example: When an assembly line switches from making almond-colored refrigerators to white ones, SMART ensures the right-colored subassemblies move into the production flow at the right time.

The system also includes a Program Device Library (PDL) that serves as a repository for the PLC programs. The PDL checks the accuracy of those programs to ensure that any factory floor changes are recorded on the system's master copy.

If a user wants to increase the number of PLCs being monitored, or add functions that weren't included in the original system, it's simply a case of adding a small computer and appropriate software. The software can be used on a single computer, or distributed to multiple computers. At the refrigerator plant, several small computers are networked using Ethernet.

For more information from GE Fanuc, **circle 31.**

GTE Automates Headlight Assembly

GTE's Miniature Lighting Div., Hillsboro, NH, makes halogen headlamp assemblies for Ford, Chrysler, Audi, Toyota, and Hyundai. They are made with the aid of a two-axis vision system, robot, and two laser welders.

The automated lamp line consists of six subassembly stations connected by an umbilical conveyor. "At the first station, plastic bulb sockets are delivered, etched, and inspected," says Ralph Cooper, GTE's senior equipment design engineer. "The terminal lugs are fed into the socket base and twisted into place. A locking sleeve base is installed and each socket is individually loaded into a bulb/socket carrier, where it remains throughout the rest of assembly.

"At the next station, bulbs are delivered in capsule form. The finished glass bulb encloses the bulb coils (the bulb looks like a medicinal capsule). This station welds leads and a retainer jacket to the capsule's base. A machine inserts the bulb into a socket and the conveyor moves the bulb/socket carrier to the preliminary Z-axis adjustment station. A locking sleeve is located and bonded in position and the carrier proceeds to the focusing stations."

An asynchronous umbilical conveyor distributes carriers to the focusing

CONTINUED P. 54

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stations via a decision-making triple-gate mechanism. A fixturing jig simulates the final (as installed in the auto) registration plane and seats the socket flange over the entire 360° of the flange. An elevator raises and locks the carrier up through the open throat of the robot's end effector.

The end effector grips the capsule and the microprocessor initiates the dual camera vision sequence. The vision system views the coil positions relative to its ideal focal point within the lamp assembly. A microprocessor then calculates and transmits the necessary 3-D offsets to the robot controller.

The robot, a Seiko RT2000, moves the prescribed offset distances. The robot's moves are all from an unknown point to a theoretical point. "It doesn't move the bulb linearly," notes Cooper. "The only possible motion that maintains welding position between the socket core and the retainer is a *gimbal*—a rolling motion roughly similar to a whirlpool movement. The robot and gimbaling-gripper combination execute the movement to focus the coil. Upon completion, the robot controller signals that the move was completed and the vision system verifies the correctly focused coil position."

If the bulb isn't in position, the system can repeat the cycle three times; after that the part is rejected. If within tolerance, the microprocessor commands the lasers to weld the retainer jacket to the socket core in four places. The gimbaling gripper then releases the capsule and the elevator lowers the part to the track and it continues down the line. Payback for the focusing substation was less than 6 months.

The headlamps then go through a lead wire station that welds them to the terminal lugs. The conveyor carries the bulbs though two more test stations: one for aging (i.e., lighting the filaments to verify operation), the other for final leak testing and overall inspecting. Finished product is transferred off the assembly line to a packaging machine, and carriers returned to the socket assembly machine.

Predictable, Repeatable Precision Parts

To the assembly engineer, powdered metal offers the primary benefit of precise repeatability during part production. This constancy of shape and tolerance is especially useful in automated and robotic assembly since there are no out-of-tolerance parts to jam assembly machinery. Thus, downtime should not be a factor of varying part dimensions.

An example of the extreme accuracy achieved by PM fabrication is a capstan bearing cap—and mating block— now being produced by a Wakefield, MA, sintered-metal products firm.

The company was recently contracted to make the parts for a new laser photo-imaging system built by

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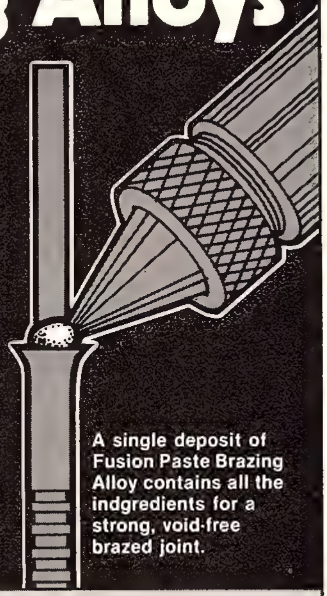

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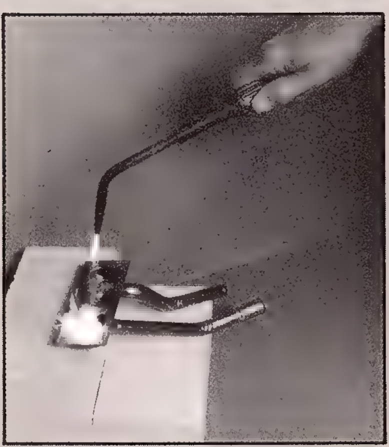

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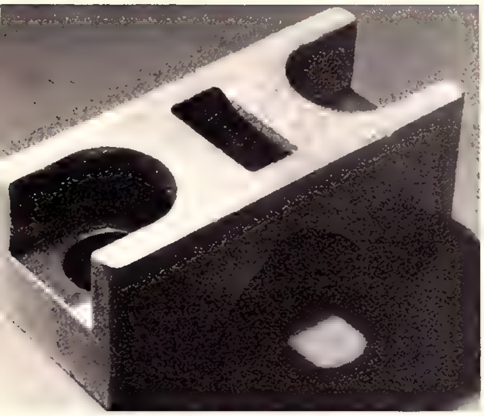


The Powder Industries Federation awarded this capstan bearing cap the 1987 grand prize (nonferrous category) in Powdered Metal Part-Of-The-Year design compeition.

Compugraphic Corp, Wilmington, MA. The small components are vital in maintaining the extreme positional accuracy required of photographic film scanned by the printing device's internal laser.

The laser printer's operation is relatively simple but very precise. A gear on the film capstan end is driven by a stepper motor. As the film advances one step, the printer's laser scans one line. This 5 ms sequence is repeated 200 times/second, and step accuracy must be within 0.000050 in. The capstan bearing cap and block's critical function calls for dimensional accuracy within 0.001 in.

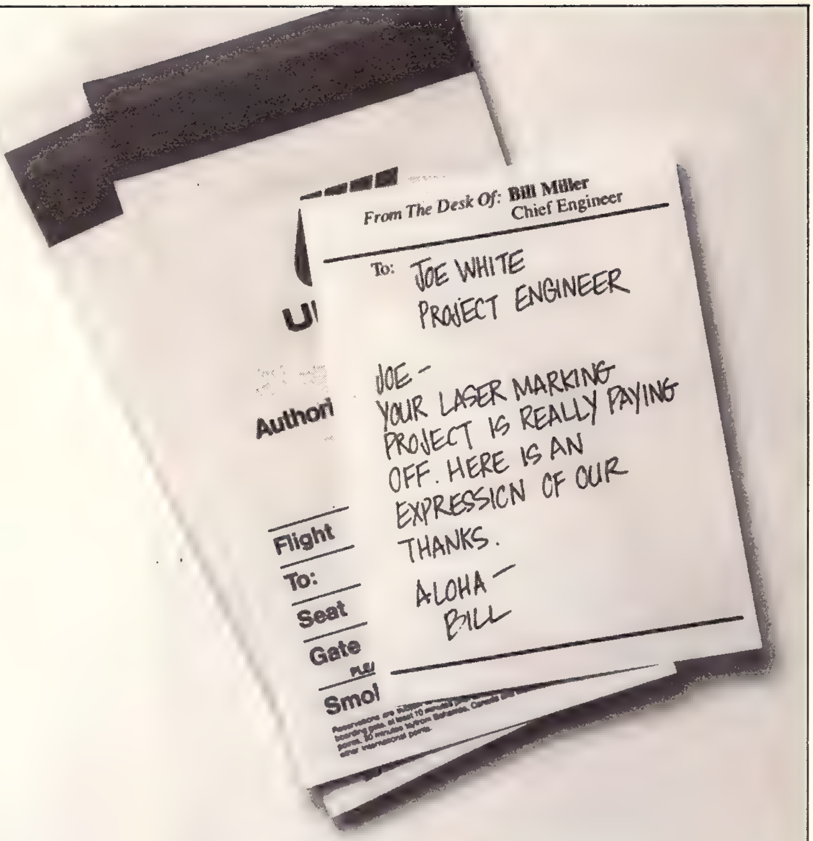
Powdered bronze alloy was specified for fabricating the parts. Besides component production repeatability, Compugraphic's senior principal engineer and part designer, Larry Blake, cites powdered bronze's inherent wear and self-lubrication properties that minimize capstan wear as primary attributes. To increase the components' durability, Wakefield was able to achieve a hardness of 50-55 R^H, the maximum for bronze.

For more on PM, **circle 33.**

Scissor Lift Cuts Assembly Time

At Ford Motor's Hazelwood, MO, plant a robotic assembly line with hydraulic scissor lift is automatically welding up to 75 parts per hour. The lift, made by American Manufacturing Co., Tacoma, WA, is designed for concentrated loads in congested, minimum space areas. It allows the line to run more than one component, and changes the vertical axis of the work. Precision, vertical alignment is automatic.

Every 48 seconds, the lift moves up and down to position a sheet-metal panel for robotic welding in several places. The part then is lowered and transported elsewhere. Installed last year, the lift is reported to be smooth and dependable, requiring minimum maintenance. For details, **circle 36.**



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Assembly Expert Goes On-line

An on-line expert system being developed by Litton Industrial Automation Systems can diagnose faults in assembly and test printed circuit boards. Demonstrated at the firm's new $10-million integrated manufacturing and software development facility (Hebron, KY), the prototype shows the feasibility of using an expert system to support an automated assembly and test cell. The same approach also applies to diagnosing problems on other electronics assembly and test operations.

Tale of the Tape

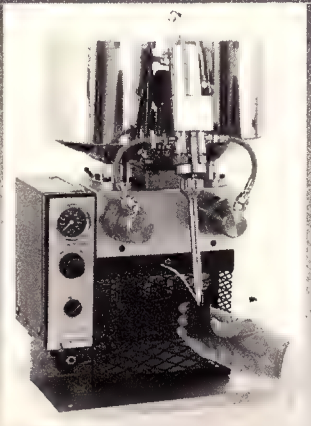
Often, the simplest processing changes can have surprising effects, as a Kansas aircraft manufacturer discovered recently. By switching a special tape that holds rivets in place, the firm improved the exterior appearance of their planes and annually saved $10,000 in clean-up labor.

The commercial airline industry has stopped painting the majority of its aircraft, instead specifying that aluminum clad aircraft skins remain bare and polished. Rivets, therefore, must look better; however, direct metal-to-metal contact between rivet head and die scars the heads. Polishing afterwards isn't possible because it removes a special corrosion coating. To protect the rivet head without affecting the protective coating, the company has applied a transparent polyester tape between the rivet head and die to hold the fastener in place and eliminate metal-to-metal contact.

Unfortunately, wrinkles in the tape were subsequently imprinted onto the rivet heads. In addition, the adhesive extended beyond the tape's edges, often transferring onto the rivet heads when the tape was peeled off.

"The residue couldn't be removed with an alkaline solvent normally used or the anticorrosion coating would be destroyed," explains a company spokesman. "Workers wasted considerable time trying to get the adhesive off mechanically. It was tedious and costly."

The company's R&D group asked Arlon, Santa Ana, CA, for help, so the firm developed a clear polyethylene tape coated with a special adhesive just along the edges. "It works beautifully," remarks the spokesman. "It doesn't wrinkle nearly as much as the polyester tape. And if it does, the wrinkles iron out during riveting. And the adhesive lifts right off after riveting." For more info, **circle 34.**



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with new, compact, meter-mix-dispense unit for epoxies, urethanes, silicones, etc.

This cost-effective, easy-to-install, meter-mix-dispense machine is specially designed for precision dispensing of encapsulants, adhesives and sealants.

The Twinflow Mini machine pumps epoxies, polyurethanes, acrylics, polyesters and other two-part systems with viscosities up to 250,000 cps at ratios from 1:1 to 15:1.

Unique, volumetric, positive-displacement piston pumps assure accurate, reliable metering of materials. Plastic disposable, Posimixer™ motionless mixer delivers a uniformly-mixed material.

For information contact Liquid Control Corp., 7576 Freedom Ave., N.W., P.O. Box 2747, North Canton, Ohio 44720-0747•(216) 494-1313.

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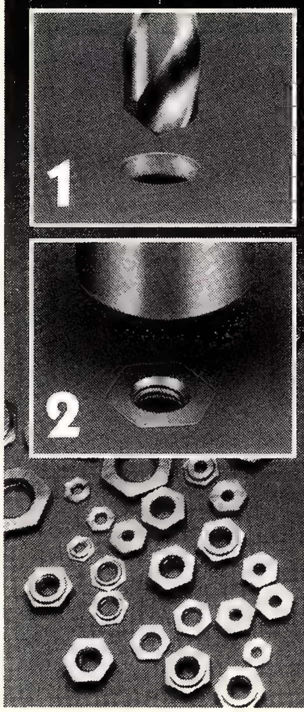

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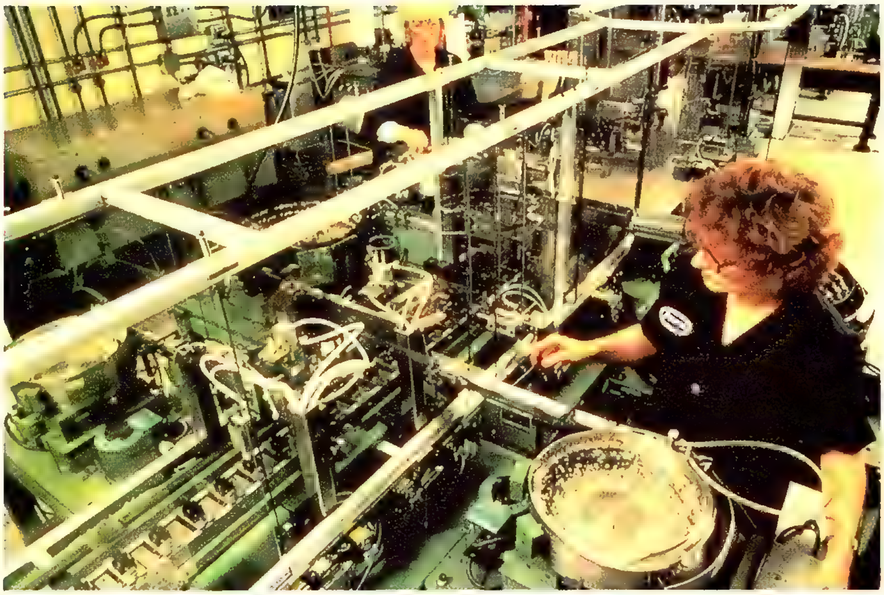
Automated Assembly Fends Off Foreign Competition



A few years ago, ADC Telecommunications Inc., Minneapolis, MN, was faced with both opportunities and threats. With the imminent break-up of AT&T and federal deregulation of the telecommunications industry, the market for the company's transmission network products was on the verge of enormous expansion. At the same time, rising manufacturing costs and intense competition threatened the firm's market position.

The company made a commitment to automate product assembly, which was the responsibility of 6 automation engineers. The group designed several innovative assembly machines based on programmable logic controllers (PLCs) and sensors from Omron Electronics Inc., Schaumburg, IL, with considerable assistance from J.E. Braas Co., Eden Prairie, MN, a local Omron distributor.

In 6 years assembly automation has helped triple the company's revenues to over $144 million.

Despite some work moving offshore, ADC has a "no layoff" rule when a job is farmed out. Automated assembly has contributed significantly to this rule's success. Most of ADC's assembly workers now run automatic machinery. The firm not only maintains employment, but its labor force has a much higher skill level. And ADC's progress in automated assembly is responsible for some impressive statistics: On- time shipment rate stands at 95% while delivery lead times have been reduced 2 weeks over the last 18 months. Average inventory turns also have increased from 2 to 4.4 over a three year period.

Machine Makeover

A seven-station rotary assembly machine for a connector illustrates ADC's automation design accomplishments. The product was originally hand-assembled in Minnesota until profit margins dwindled. The automated assembly operation is now more cost-effective than offshore hand-assembly and provides better quality control.

The rotary machine automatically inserts and assembles nickel-plated contacts and other components into a zinc die-cast housing. The housings and plastic insulators are fed into the rotary track by vibratory bowl feeders at two assembly stations. At three stations, ground and contact pins are reel-fed to the rotary unit where they are consecutively formed, cut, and inserted into the base unit.

Pneumatic devices are used at most stations to perform the necessary mechanical operations. Omron E3S-X fiber-optic photoelectric sensors and TL-W inductive proximity sensors are used for part detection. Several of the stations require 0.002 in. positioning accuracy.

An Omron C120 PLC using 208 I/O points controls and monitors the machine's operation. Two of the expansion units are mounted on the opposite side of the equipment from the CPU (over 8 feet away) to simplify I/O wiring.

The PLC uses a shift register to track products as they move from station to station. If a sensor indicates a part has not been fed, or an operation is improperly performed, the shift register will track the part through successive stations. In addition to rejecting the bad product at the end of the assembly process, the PLC disables mechanical operations that ordinarily would take place at successive stations.

The final station on the connector assembly machine demonstrates another capability—PLC-to-PC communications. The machine uses a Hewlett Packard personal computer to perform electrical tests on fully assembled connectors. The PC performs continuity, contact resistance, and electrical breakdown tests on each assembly, transmitting results to the PLC, which rejects products failing the test, shutting the machine down if there are too many. This allows 100% performance and quality testing without an inspector. Component scrap on assembly has been reduced to only 0.5-1%.

ADC also uses an Omron Sysmac C500 for other PLC-to-PC communications. For example, the C500 controls and monitors an in-line assembly machine consisting of 7 pneumatic pick-and-place devices for the company's Bantam phone-jack line. In addition to controlling assembly, the PLC monitors various performance parameters, passing the information to a PC for review and evaluation.

Machine performance can be monitored from a remote office. If failures reach unacceptable levels, a supervisor at the personal computer can command a machine to shut down.

ADC also uses PLC data logging for production and capacity planning. With the data, production runs, delivery dates, and parts inventory are planned more precisely, which has reduced average lead time by two weeks and inventory cost by 30%.

For more on how PLCs can augment automated assembly, **circle 35.**

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MIX-PAC's three available nozzles allow accurate placement of material even in difficult to reach applications. Since mixing is done in the nozzle, simply dispose of the nozzle when done, no clean-up required.

MIX-PAC features a durable, high quality dispensing gun and low cost, disposable cartridges and mixing nozzles. Applications include assembly, maintenance, field repair, construction or anywhere 2-component adhesives or sealants are used.

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Get Down to the Business of CIM

If the subject of automated manufacturing seems just a little too clean, too cool, too abstract...And you feel like some purely technical viewpoint is dominating your company's thinking on this crucial strategic matter... Then it's time you investigate CIM in a manager's element.

It's time you come to AMS.

At AMS, you have a unique opportunity to explore CIM as a real-life business proposition, an opportunity to take charge and be an active agent in your CIM education and planning processes.

The exposition (featuring 175 leading vendors of factory automation) constitutes a free market of information on CIM tools and techniques—the free market required for the gathering of objective facts. Furthermore, the exhibitors are as inclined to talk business dynamic, approach, and track record in modern manufacturing as they are inclined to talk bits and bytes and rate of flow.

AMS also offers a management-oriented Conference Program, with blocks of course work dedicated to Strategy, Integration, Information Management, Design, Production, Automated Material Handling, Storage and Distribution.

And IMPACT™—a special exhibit featuring a live, working demonstration of factory automation— dramatically illustrates how to plan and implement CIM in a real-world, multi-vendor situation. IMPACT '88: produced by KPMG Peat Marwick: Co-participants: CAM Software, Intergraph, American Software, Texas Instruments, Interactive Images, Stratus, Gould, Chipcom, Auto Simulations, Intermec, Palladian Software.

For more information on attending AMS, including a detailed Conference Program, call or write: AMS Registration, Cahners Exposition Group, 1350 East Touhy Avenue, P.O. Box 5060, Des Plaines, Illinois 60017-5060: (312) 299-9311.

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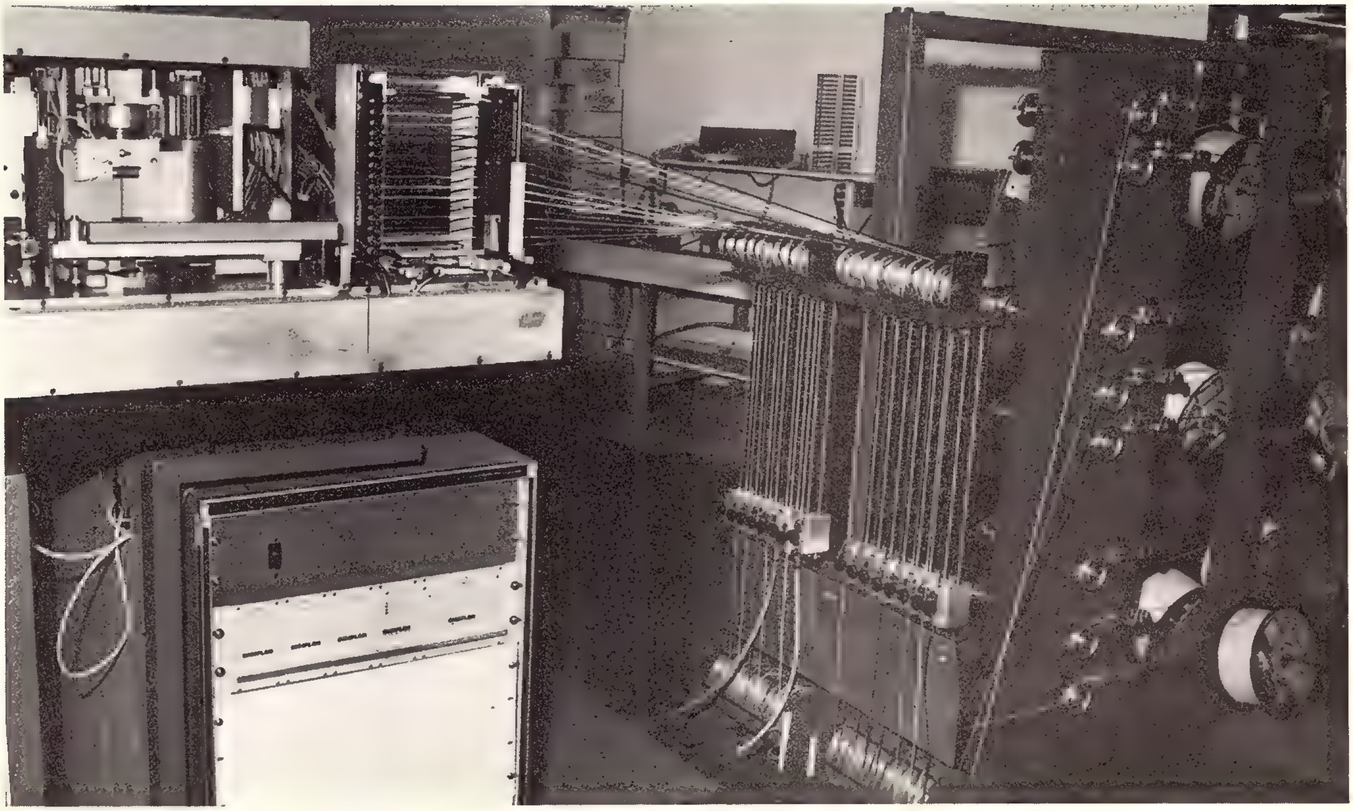


Automated Wire Processing

WPS is a new processing system designed to eliminate wire production setup time and paperwork for cables and harnesses.

The system can be used for mass production of identical wires at a rate, for a 2-foot length, of about 2400 wires per hour. It also can produce more sophisticated wire products, such as:

- Sequences of wires with different gauges, colors, marking, lengths, and terminations. The wires may be gathered at the output by hand, delivered to another machine, or spaced closely in groups or sub-groups for insertion into connectors or for bonding, tying, taping, etc.
- Unlimited daisy-chains, including different terminals and different wires.
- Very long wires looped into hanks.

WPS can produce a mix of these products to deliver all components of a harness, i.e., a sequence of 20 different terminated wires, a grounding daisy chain including 5 wires, and an extension cord made up in a hank.

System functions include selecting a wire to be processed from 1 of 15 reels, cutting the wire to length, and identifying it by ink jet, laser or hot stamping. Wire then is loaded onto a conveyor, with the wire ends protruding from one side or from either side, and presented to a series of end-processing modules that will strip, crimp, tin, install housing and sleeving, or perform other functions. The ends of adjacent wires in the same terminal can be crimped to form a daisy-chain or to insert into a connector. System can also tape or tie a hank or individual wires.

Each end-processing module occupies a 4-in. wide space, contributing to the compactness of the machine which will accommodate up to 16 modules. The crimping modules each have 4 crimping heights that are program-selectable. The stripping modules can be set up for 5 gauges and 5 strip lengths, with each gauge and length program-selectable.

Batch processing modules are installed at the output end of the machine for taping or tying, or for inserting wires into a common housing.

A wire supply rack and dereeler accommodates up to 15 reels 14 in. in diameter. A motor driven capstan dereels the wire on demand from the wire selector and feeder, which selects and feeds one of the available wires to the loader on command from a PC.

The PC provides machine and plant level communications, man-machine interface, process control management, and statistical process control.

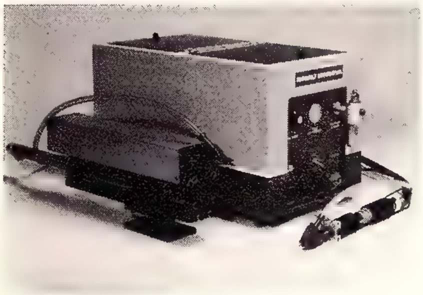
The system also incorporates several control command modules that are expandable. Each has a keyboard-display located at the machine, giving the operator access to any process or maintenance purposes, such as step-by-step operation and fault override diagnosis.

The WPS can be configured to maximize the variety of wires produced by moving, adding or replacing end-processing units. The identity, address, settings, etc. of each unit are entered into a machine configuration file in computer memory. This file defines each wire by source number, length, terminations, etc. Using several look-up tables that are filled only once minimizes the operator-entered information needed for each wire. For example, asking for a given housing could be enough information, with the table supplying terminal reference and strip length.

Data can be supplied to the machine from the PC keyboard-display, from diskettes with data prepared off-line, or through the PC from a higher level computer.

Eubanks Engineering **CIRCLE 41**

Portable Screwfeeding



This automation component may be tooled for up to 1.5 in. long screws and is designed to stack easily for multiple installation. All controls are assembled as plug-in units for easy maintenance. All components are hardened tool steel, with automatic bowl shutoff and steel sound enclosure as standard equipment.
Assembly Automation Industries
CIRCLE 42

Skinny Ties

Slim Line cable ties include 8 in., 18 lb and 15 in., 40 lb tensile strength ties. They are suitable for applications where there is tight space and a need exists for a smaller head and/or a thinner tie.
Dennison Manufacturing Co. **CIRCLE 43**

Epoxy Adhesive

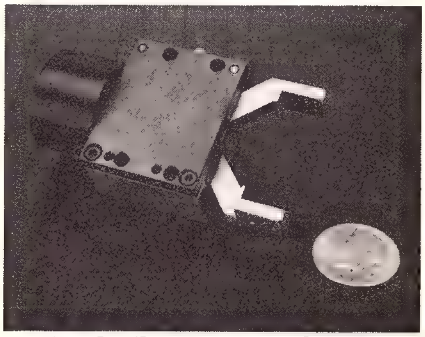
Two-part, high-performance system produces strong, impact resistant bonds to urethanes and other thermoplastic and thermosetting materials. It mixes quickly to a smooth, medium-viscosity fluid with excellent flowing and wetting properties. Overnight cure at room temperature results in a tough, resilient product that adheres tenaciously to urethanes and many other plastics, as well as to ceramics, metals, wood, and concrete. Fully cured TRA-BOND 2135D has superior resistance to moisture, mildew, gases, many dilute acids and alkalis, salts and salt solutions, many solvents, and petroleum derivatives. It is an electrical insulator and will not support galvanic corrosion.
Tra-Con **CIRCLE 44**

Colorful Cure

Tra-Bond F230 is a high temperature adhesive with a novel color-keyed cure feature recommended for bonding fiber optic bundles, potting glass fibers, and terminating single or multi-channel plastic or metal fiber optic connectors. Each of the two unmixed components is light yellow. When mixed together, the resulting formulation is light green. Once applied and fully cured, the adhesive changes to reddish-amber. This color change feature is a convenient quality control check and eliminates the need to monitor the curing cycle.
Tra-Con, Inc. **CIRCLE 45**

Mini-Grip

PG-050 is a true-parallel automatic retriever engineered for limited space and access applications. Overall dimensions are 1 x 2 1/8 x 4 in., with 0.5 in. total parallel stroke. Applications include ID as well as OD gripping. Mini Para-Grips are designed for high cycle life and high temperature applications.



Arobotech Systems, Inc. **CIRCLE 46**

Go ahead, Screw it up ...or down ...or any angle in between.

Stick-Screw's unique small part fastener system lets you drive screws straight up, straight down or at any other angle. No need to reorient or move the part. Self-seating hex screws are driven home and snapped off when proper torque is reached. Rejects and rework virtually vanish. Quality and productivity increase — even with unskilled operators. Call direct or write for detailed literature on the Stick-Screw assembly system.

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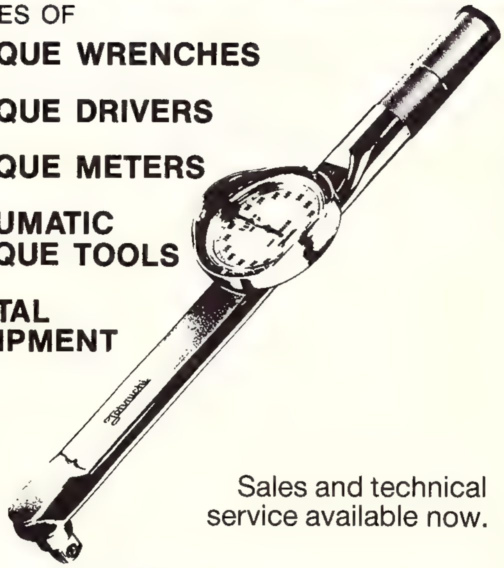

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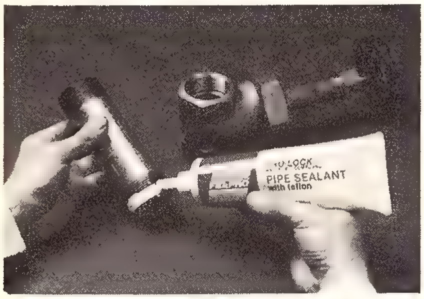
Leak Prevention



Pro-Lock hydraulic sealant is specially formulated to be used with brass hydraulic and refrigeration fittings and couplings. It effectively seals fluids and gases even under shock and vibration. Using a silicone sealant keeps ductwork sealed and air moving at peak efficiency. Fel-Cobond operates under temperature conditions from sub-zero to over 400°F.
Fel-Pro, Inc. **CIRCLE 47**

Dispense Valve

The NO-DRIP® SNUF-BAK® draws or "snuffs" back a small amount of flowable material to ensure no-drip use for messy, high-viscosity epoxies, silicones, urethanes, greases, and other materials. Pressure rated at 3500 psi, the valve has teflon seals with an adjustable wet cup to prevent drippage on the shaft. Valve measures 2.25 in. in diameter by 5 in. length and is adaptable to a variety of nozzles. It can be manually controlled or robotically interfaced. Where corrosive materials are a problem, stainless steel can be substituted for standard construction.
Sealant Equipment & Engineering, Inc. **CIRCLE 48**

Bonding Repair

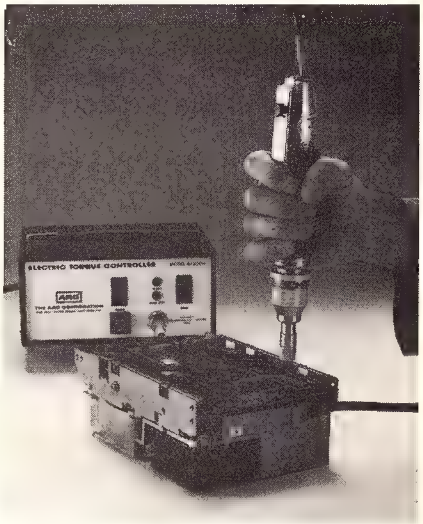
The MRSI 781 inspects tape automated bonding devices for alignment and solder defects, while the MRSI 804 both inspects and repairs TAB devices with lifted/open bonds. The MRSI 781 is a completely automatic inspection system equipped to handle the small geometries found on today's high lead count TAB packages. Capable of inspecting packages with over 200 leads, the 781 automatically identifies misalignments, shorts, solder balls, and solder pools, providing an operator with detailed data regarding defect classifications and locations. The MRSI 804 is designed to assist an operator in detecting and repairing defective outer lead joints not completed during bonding.
Micro Robotics Systems Inc. **CIRCLE 49**

Wave Solder SPC

PC-based system increases yields and reduces touch-up costs in wave solder. Wave Watch combines real-time process monitoring of wave solder parameters with an integrated database of circuit board characteristics, process target settings, and solder defect information. These functions, coupled with the system's retrieval and report capabilities, including X-bar and R charts, allow documenting of actual conditions and establishing and refining process settings. It is appropriate for retrofit installation with either microprocessor controlled or manually operated wave solder machines. Wave Watch monitors preheaters, solder pot, solder wave temperatures, conveyor speed, ambient temperature, ambient humidity and flux density.
Manufacturing Technology **CIRCLE 50**

Quick Reversing Screwdrivers

QRT tools features the Quick-Reverse Touchtrol™ trigger that enables significant time savings for applications in which reversing or fastener realignment occurs frequently. It also allows the operator to always have a free hand. Variable-speed trigger enables the operator to "sense" the desired speed to accurately start and run down the fastener. Tools are also equipped with automatic shutoff clutch for controlled torque output.
The Aro Corp. **CIRCLE 51**



Load 'Em Up

The 900DBL barrel loader transfers thick fluids, such as solder paste, grease or silicones, from cartridges to easily handled barrel/syringe reservoirs. Preloading 3 to 30cc barrels increases productivity and eliminates reloading procedures during dispensing. Efficient transfer of the paste also reduces entrapped air in it to ensure continuous, accurate dispensing.
EFD **CIRCLE 52**

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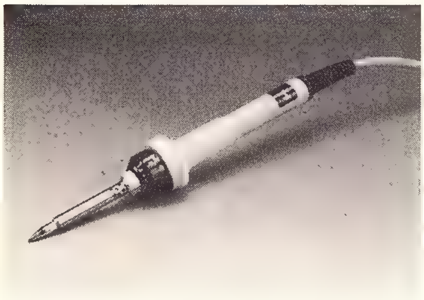
Improved Legend

The Legend AEAD-200LE engine driven welding generator has a number of improvements. It is powered by an Onan Performer 2-18XSL, a horizontally opposed, twin cylinder gasoline engine with longer life and smooth operation. Generator is designed for shielded metal arc (SMAW) welding at 225 amps ac, 200 amps dc, constant current, 100% duty cycle. Gas metal arc (GMAW) and gas tungsten arc (GTAW) welding is possible with optional equipment.



Miller Electric Manufacturing Co. **CIRCLE 53**

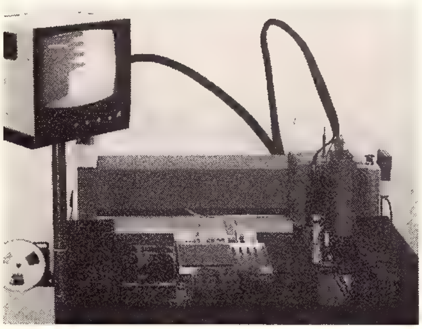
Blind Rivets

POP® multi-grip rivets are designed for applications where different material thicknesses normally require several rivet sizes. They feature high mandrel head retention capabilities, forming a tight, weather resistant seal. The rivets are also hole size tolerant, adapting to irregular, over sized or misaligned openings. Designed with aluminum bodies and carbon-steel mandrels, they come in 1/8, 5/32, and 3/16 in. diameters for hole sizes ranging from 0.13 to 0.205 in. They are also available in either domed or countersunk heads in 1/8 in. body diameter and provide grip ranges from 0.039 to 0.504 in.

Emhart Fastening Systems Group **CIRCLE 54**

Eyeballing Assembly

The Assembler uses a vacuum nozzle chuck to pick up the component without disturbing its gull-wing leads while an upward-looking camera visually positions the component. Another camera views downward to detect board offsets and, if any are found, to correct for them. To facilitate accurate component placement, a 10,000 step theta rotation (with 0.036 degree increments) enables the Assembler's head to move in very fine increments providing not only enhanced component control, but also improved placement accuracy.



Quad Systems **CIRCLE 55**

Flux Dryer

An automated system for recycling welding flux slashes preheating time from a typical 8 hrs to 15 min. The system, intended for heavy-section/plate/welding, is built around continuous flux drying/stoving/techniques and a MEFC 60 chamber that bakes dry up to 100 liters of flux an hr. The chamber 70 resistance heater operates at up to 600°C. CERF produces better quality welds because of close control of flux humidity. It uses turbine-blown hot air to drive flux into the MEFC 60 drying chamber, unlike other systems that use compressed shop air.

MATAIR, S.A. **CIRCLE 56**

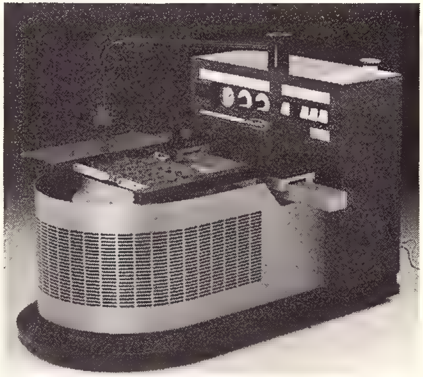
Ceramic Adhesive

Ceramabond™ 632 is suitable for use to 1200°F. The material closely matches the coefficient of thermal expansion of glass/ceramics, and after curing at 300°F will produce a strong bond.

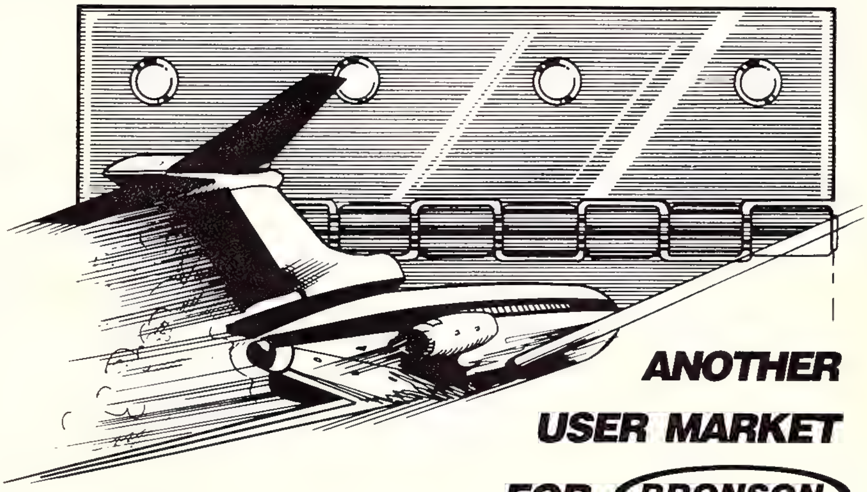
Aremco Products, Inc. **CIRCLE 57**

PCB Reflow Modules

The PCBRM-12 generates a restricted solder wave for a fast, safe method to remove, replace or selectively solder all multi-leaded thru-hole components. Major improvements to the series include low profile modular construction to allow clean, compact work area and a linear bearing pc board carrier mechanism providing precise component location.



Air-Vac Engineering Co. **CIRCLE 58**



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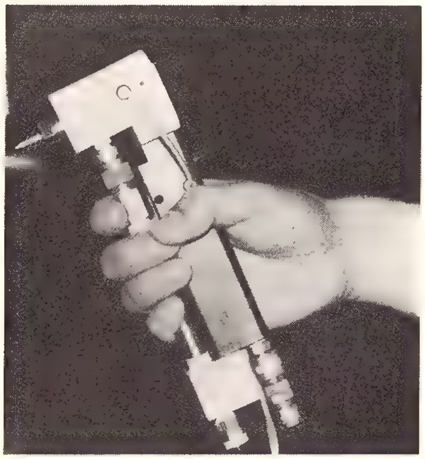
Automatic Meter

Two component short pot life resins are precisely mixed and dispensed from large reservoirs via a hand held mixing/control gun. The Tridak Model 1550M Dispense System can apply microliter quantities of thoroughly mixed resin or alternatively, a continuous flow can be maintained. The handpiece contains both a disposable static mixing tube and a dispense control valve. Two reservoirs holding polyethylene cartridges contain the resin components. The Model 1550M accommodates resins requiring a mix ratio of 1:1 while the Model 1575M will handle ratios from 1:1 to 1:10. Both models have a solvent flush to cleanse the system in the event of prolonged delay between dispenses.



Tridak **CIRCLE 59**

Carrier & Cover Tapes

Designed to transport active components, this system uses a heat-activated adhesive to join the cover tape to the carrier. Adhesive exhibits minimal aging and enables a consistent peel force on pick-and-place equipment, which assures efficient delivery of the SMD to the board assembly. Two cover tapes are available: a plain, insulating type and an antistatic variety; both are clear to allow visual inspection of the components.

W.H. Brady Co. **CIRCLE 60**

Slim Line

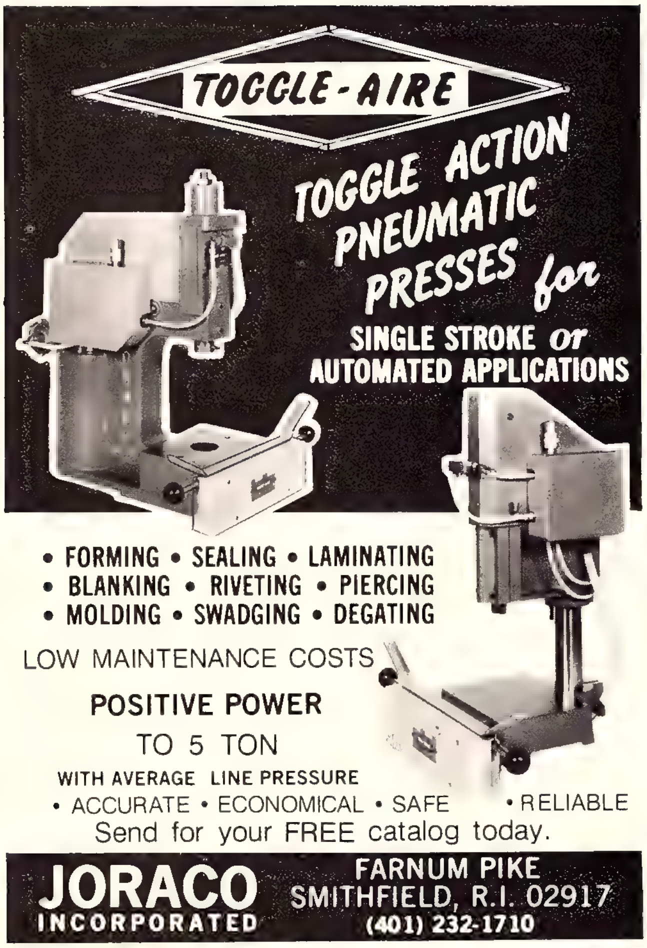
Test-proven screwdrivers offer the needed strength for driving, tightening and removing small screws and fasteners without prematurely wearing or breaking. Bright yellow, 3/4 in. handles incorporate a black ball end with a guiding point and flats on a ribbed waist for easy operation. Shank and tip size are prominently printed on the handles.

Ideal Industries, Inc. **CIRCLE 61**

Torque Monitor

Portable multi-channel monitor, featuring statistical process control capability, is used for setting up and testing single- or multiple-spindle nutrunners equipped with transducers. Housed in a suitcase-style carrying case, the Model 574 portable monitor is designed to display and record peak torque readings and provide data for the readings stored. It has inputs for up to eight channels and memory capacity is 100 readings per spindle.

GSE, Inc. **CIRCLE 62**



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Soldering System

A standard system is comprised of an RF Roller Flux Coater that applies a specified amount of flux, a rheostat-controlled oven to set the flux and preheat the board, and a Roll Soldering System, that applies molten solder to the bare copper circuitry. Double Roll Soldering System, that incorporates a second roll soldering machine, is also available. All systems use stainless wire-mesh belt conveyors and provide variable speed from 1 to 30 lfpm. Complete systems are approximately 12 ft and come in both 18 in. and 24 in. widths.

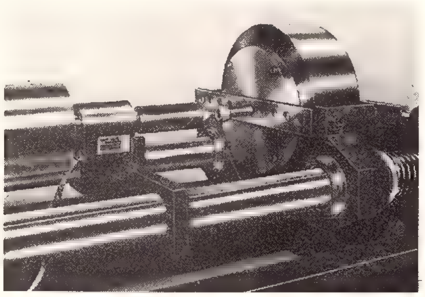
Union Tool Corp. **CIRCLE 63**

Design Software

ANVIL-1000MD® CADD mechanical engineering software now runs on the IBM Personal System/2. The minimum recommended configuration is a PS/2 Model 50 with optional 80827 math co-processor. The system provides good responsiveness for most applications with the standard 1 megabyte RAM. Drafting features include notes, labels, complete automatic dimensioning, cross-hatching, modification and more. Large drawings with as many as 20,000 entities may be handled, and orthogonal and isometric views can be constructed automatically. Designs can be transferred to workstation, superminicomputers, and mainframes.

MCS, Inc. **CIRCLE 64**

Locknut Test



The ACCRAT Analyse II automatically tests self-locking nuts according to customer quality specifications and documents the measured data. The system monitors its transducers to ensure 0.25% full scale accuracy. Certification of the customer's specs can be printed for each shipment with PC software. Test parameters for production-line testing, incoming quality control and R&D testing include on/off, seated torque, clamp load, degree of rotation, RPM, etc. Even complex test specifications are easily programmed with menu blocks. Tests can be programmed on a host PC and stored on floppy discs so the test can be repeated on demand.

Intech **CIRCLE 65**

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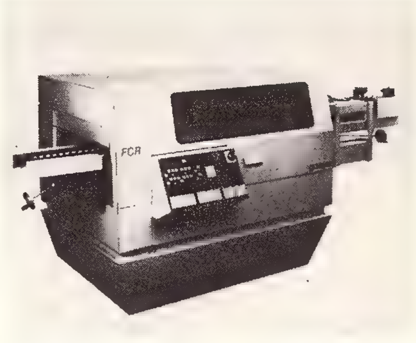
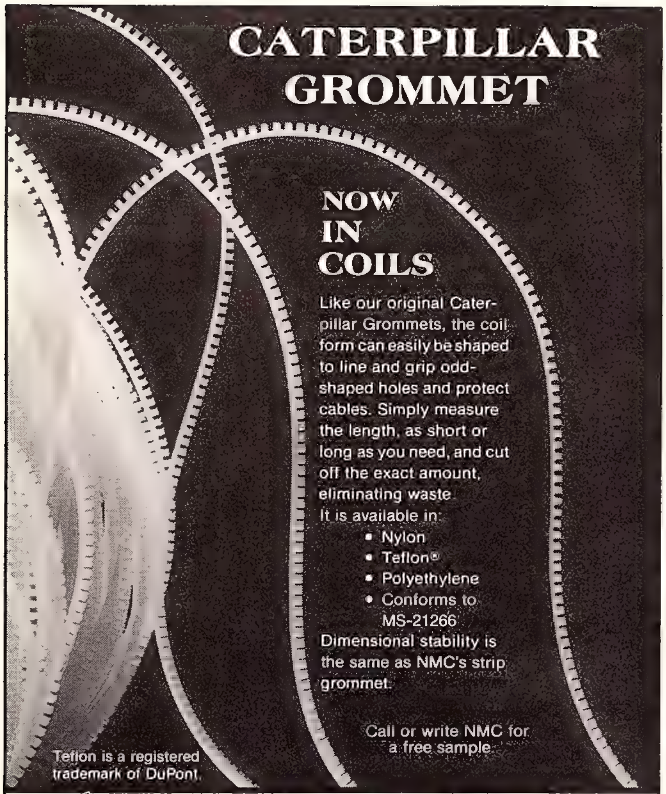


This system achieves 100% reflow on high density boards, including those with nested components. Convection reflow prevents component thermal shock and reduces exposure time at elevated temperatures. The reflow activator eliminates low through-put, and lead oxidation.

Hollis Automation **CIRCLE 66**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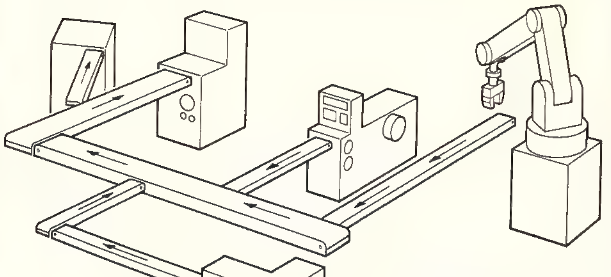

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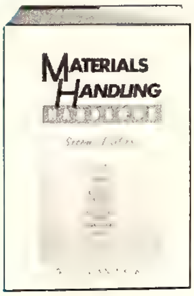

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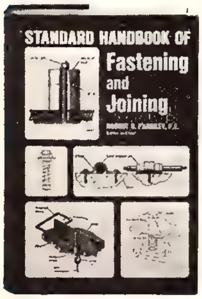

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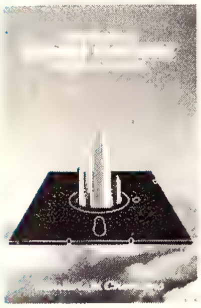

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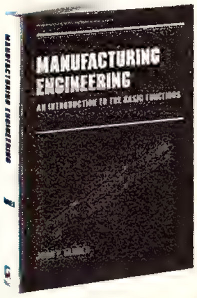

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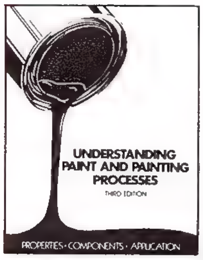
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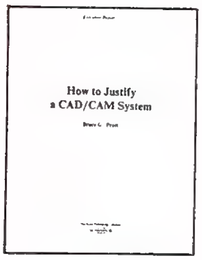

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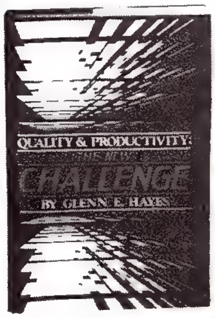

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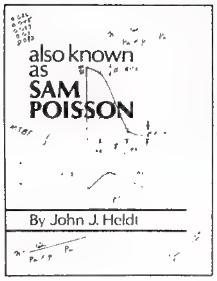

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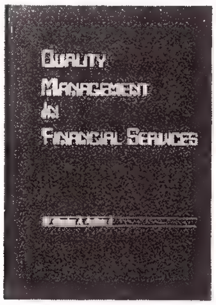

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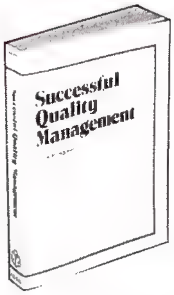

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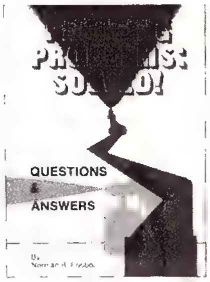

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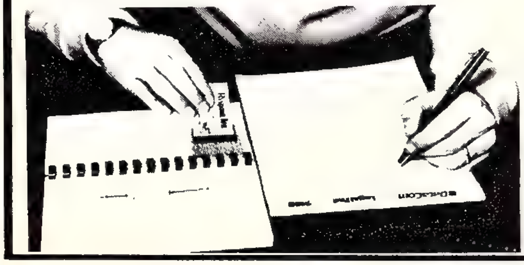

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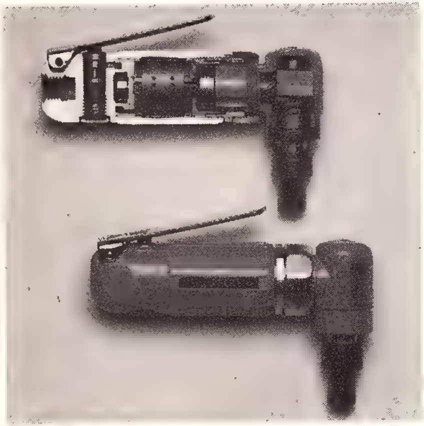

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The VIRE 2 features automatic multi-head bending and automatic hopper feeding. Each of the bending units can be selected into or out of action by switches, and up to 10 bending heads are available. It uses a centralized clamping device and bending operations occur left and right of the clamp. A patented rotating clamping device is available as an accessory for producing three-dimensional bends; each of the bending units can be adjusted to bend wire to a preset angle.

Hudson Automatic Machine & Tool Co.
CIRCLE 68

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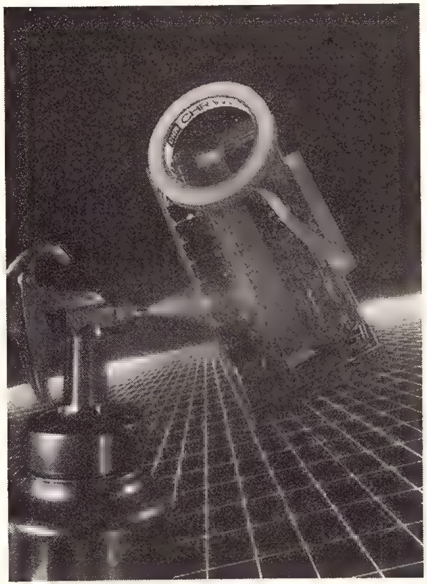

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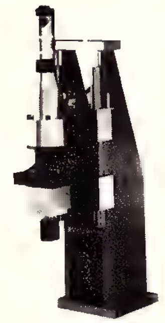

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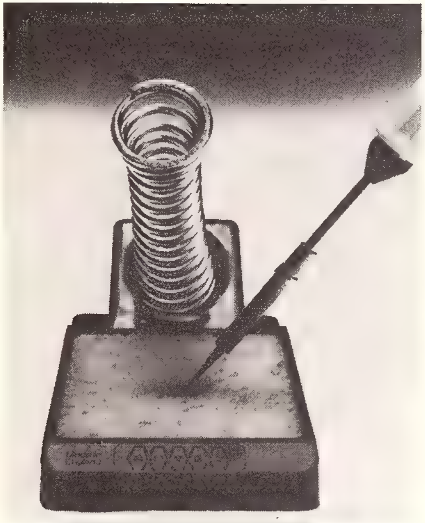

A sturdy, soldering iron stand offers a noncharring base with a coil spring holder that dissipates heat to prolong tip life, and includes a 1/2 in. thick sponge for tip wiping along with a center hole for collecting excess dross. Designed for all miniature soldering irons, the ST-4 measures 6 x 2.5 in. and has four non-skid, non-scratch rubber feet to keep it in place.

M. M. Newman Corp. **CIRCLE 73**

Electronics Assembly Software

Software developed to control programs for robotic assembly of pc boards is claimed to cut program development time by up to 50% compared to high-level languages such as BASIC or Pascal. IDEA works with Intelledex robots and vision systems using an IBM PC/AT compatible. It enables rapid development and editing of workcell control programs for board assembly of through-hole, SMD, and hybrid boards. The package includes disk-based software, multi-tasking board, mouse, manuals, and cabling.

Intelledex, Inc. **CIRCLE 74**

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E-Z Lok **CIRCLE 75**

Automatic Material Dispenser

New small bench top X-Y-Z dispenser is programmable for automatic dispensing of adhesives, epoxies, greases, sealing, and other materials. Work space is from six in. x six in. to desired size. All three axes are programmable. Vision, XYZ calibration, height sensing, and communications linking to other factory automation are available. An enhanced microcomputer with color monitor is included. Machine operating instructions are embedded in the 20 mbyte hard disk. Coordinates are entered either by a digitizer or keyboard input, on- or off-line.

Otto Equipment **CIRCLE 76**

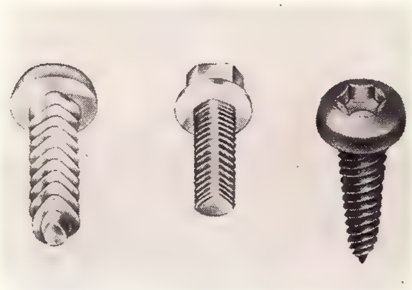
Indexing Conveyor

Magic Fingers features Delrin® belting with integrated pick-up stations that nest and transport products with round or unstable bottom surfaces. Indexing speeds are variable to 80 fpm, and product placement is accurate to ±0.005 in. station-to-station, with adjustable dwell times to perform imprinting, insertion, or other operations. Compatible with all computer controlled and factory automation systems, conveyors can be manufactured from 6 to 60 in. wide and range from 8 to 20 ft long with up to 25 lbs/sq ft capacities. Pick-up stations are designed to customer requirements.

Custom Fabricators, Inc. **CIRCLE 77**

Several Screws

Taptite® tri-lobular screws roll-form strong, high integrity threads in drilled, cored, or punched holes in ductile metals and castings. Plastite® tri-lobular screws are used for fastening in a broad range of thermoplastics and certain thermosetting compounds. Torx® Drive Systems incorporate hex-camless head design into complete driving systems delivering clamping force through efficiently transmitted rotational torque.



Lewis Screw Co. **CIRCLE 78**

Better Seal

A process that controls the rubber compounding and molding techniques ensures that all extractables are eliminated. The result is a stable gasket compound that reduces out-gassing to a negligible level in high capacity, hard disk drives.

Hiawatha Rubber **CIRCLE 79**

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CIRCLE 401 on reader information card

Bench Assembly Press

Perfect for short run production, R&D Centers, MROs, and service technicians, the press is capable of low volume mass termination of various IDC connectors on flat (ribbon) cable. Convenient, quick, and easy to use, the 1/4 ton manual press has interchangeable base plates (no tools required) and accommodates a broad range of IDCs, including female socket transition connectors, card edge connectors, standard DIP plugs, and D-subs. Interchangeable base plate terminates up to 64-pins.

PanaVise Products, Inc. **CIRCLE 80**

Automated Dispensing

Without requiring a computer or a programmer, DispenseMate combines a hand-held syringe dispenser from any manufacturer with X-Y-Z positioning system. Unit is designed so production workers can teach the dispensing sequences, allowing short runs to be automated. Inventory is reduced because Dispensemate performs on an as-needed basis. Any epoxies, adhesives, solder pastes, solder masks, RTV silicone, sealants, greases or oils dispensed with hand-held syringe dispensers can be automated.

Asymtek **CIRCLE 81**

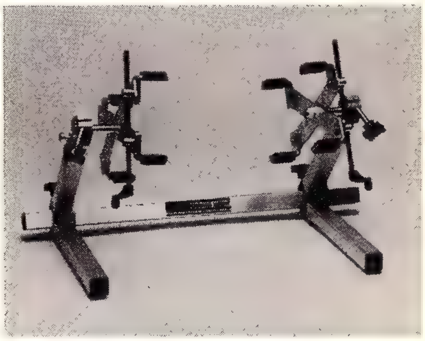
Cable Assembly

Custom high-speed assemblies offer customer-driven engineering solutions, enhanced by computer-aided technology and supported by extensive electromagnetic and environmental testing. All assemblies are precision constructed to customer requirements using state-of-the-art termination techniques. Each assembly is 100 percent electrically tested and fully inspected to guarantee reliability.

AMP Inc. **CIRCLE 82**

Chassis Mount

Offering a load capacity in excess of 100 lbs, PanaVise has a width capacity of up to 18 in. Upright arms, legs and crossbars are made of 1.25 in. square aluminum alloy tubing and allow pivot-center height of 9 in. from work surface. A positive lock detent is visible while rotating the chassis heads, and a visual indicator shows when the safety latch is engaged or disengaged. All-metal friction brakes allow for either left- or right-hand operation and are located at a natural angle for a seated operator. Model 601 includes scissor clamps that have 360° swivel jaws for holding odd-shaped chassis. Model 602 has heads that open a full 9 in.



PanaVise Products **CIRCLE 83**

Epoxy Adhesive

Adhesive sets in as little as 10 minutes at room temperature. Zyvax 600 possesses high electrical resistance over a broad range of conditions, virtually eliminating leakage currents. Applications include hybrid circuit assembly, wire hold down, PWB repair, conductive path bonding, insulation, and protection.

Zymet, Inc. **CIRCLE 84**

Self Retaining Screw Grommets

SRSGs, for fastening thin gauge panels, snaps into a prepunched 0.25 in. square hole. Designed for use with a #6 screw, the device insulates against heat and electrical transfer and provides corrosion and vibration protection. Grommet also eliminates nut and bolt assemblies, does not require cross threading and reduces installation time.

Richco Plastic Co. **CIRCLE 85**

Versatile Strippers

This model is designed for stripping enamel insulation from 30 through 46 AWG wire, such as that used in armatures and coils. Cone-shaped fiberglass brushes allow stripping to within 1/8 in. of parts, yet fingers are shielded by a V-notch guard. Urethane belts, 1/4-horsepower motor, and rugged chassis assure long service life.

Ideal Industries, Inc. **CIRCLE 86**

Tape On Spools

Double sided, pressure sensitive, polyethylene foam tape is now offered on spools that allow the user to continuously apply pressure sensitive foam to a product, at a specific rate. With lengths up to 4000 ft, Stik II spools require less changeover time and are designed for high speed operations. For use by extruders, appliance manufacturers, computer assemblers, and automotive designers, the tape comes in thicknesses from 1/32 to 1/8 in.

Stik II Products **CIRCLE 87**

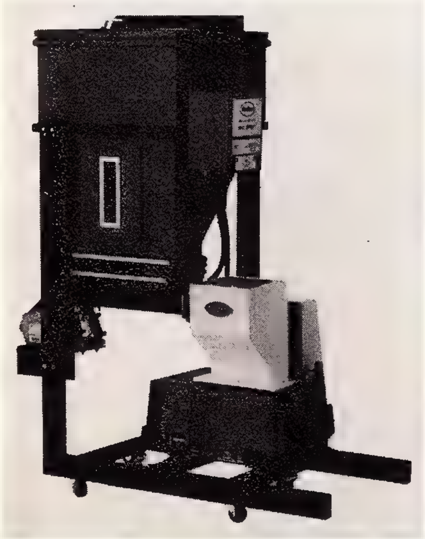
Parts Pressing

Modular, compact presses are available in two modes linear (Part No. PP1) and heavy duty progressive (Part No. PP2). The linear press provides a maximum force of 450 lbs at a 50 mm stroke using shop air at 72 psi. The progressive press provides for 3000 lbs of force also using a 50 mm stroke and 72 psi shop air. The end positions of both presses are controlled by inductive proximity switches. An optional intermediate stop is available as a second depth stop.

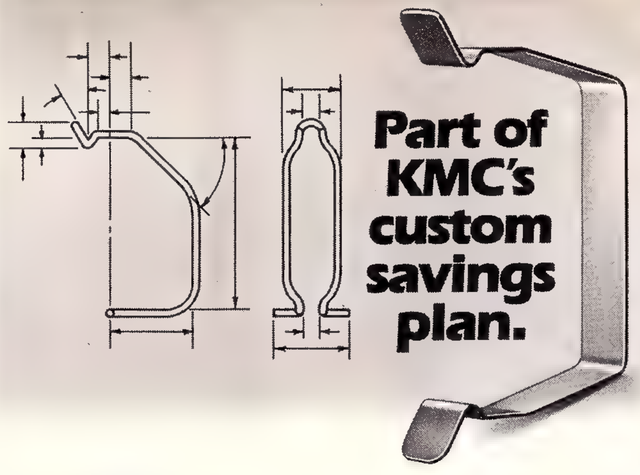
Ebosa **CIRCLE 88**

Hot-Melt Hopper/Feeder

New automatic system maintains constant adhesive levels in hot-melt applicators. Covered hopper stores and feeds various dry adhesive forms like pillows, slats, pellets and granules, without clogging or bridging. In addition to preventing empty or overfilled tanks, the hopper/feeder maintains optimal applicator levels to help prevent thermal shock to molten adhesive materials caused from filling a tank that has run low. Holding capacity of 125 to 180 lbs of dry adhesive eliminates frequent tank refilling.



Nordson Corp. **CIRCLE 89**



Part of KMC's custom savings plan.

Looks like an ordinary clip, doesn't it?

But for one of our customers, it represents a considerable cost saving.

The Problem: The customer asked us to produce a quantity of wire-form clips to be used to secure air filter covers. Our engineers took a look at the drawings, and suggested that a clip made of ribbon stock might be just as effective, and easier and cheaper to produce.

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The Moral: At KMC, we have all the tools and equipment to turn out an amazing variety of custom clamps, clips, brackets and Fourslide parts. And we have something extra. People who are always looking for ways to make a good thing better.

For more information on our custom stamping capabilities, give us a call. Who knows . . . maybe you'll be part of our custom savings plan. 465-004

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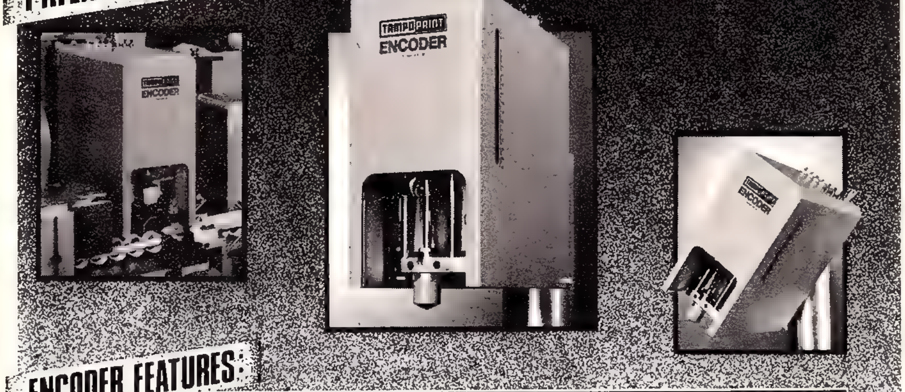

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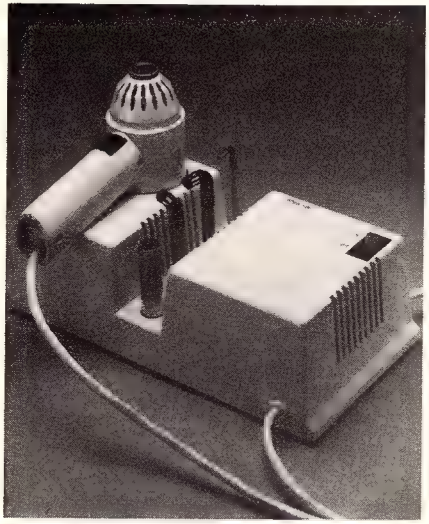
CIRCLE 403 on reader information card

Curing Light

Light weight, hand-held light source is designed for curing adhesives. Its gun style is ideal for exposing small areas of UV adhesives and is available with five choices of fiberoptic guides. All guides rotate 360 degrees allowing the operator greater versatility directing the light. It is recommended for curing UV materials in such applications as mounting precision parts in electronics and optics, pc board repairs, wire tacking, lens bonding, fiberoptic splices, and terminations.



EFOS **CIRCLE 90**

Contract Brazing

This vacuum furnace has a work zone 100 in. diameter by 85 in. high, and is capable of bringing large, heavy workpieces to temperatures up to 2300°F in a 10^{-5} torr vacuum. Assemblies of titanium, zirconium, molybdenum, and tantalum can be successfully processed. Microprocessors are employed for controlling both heat and vacuum levels. The high-capacity vacuum pumping system can reach and hold very low vacuum pressures.

Wall Colmonoy Corp. **CIRCLE 91**

Support Post

Threaded male, HMSP-TM, with a #6-32 thread, can be used to secure a more positive fit. The miniature post snaps into a 0.152 in. diameter hole and ranges in height from 1/8 to 7/8 in. The hex design allows easy installation by hand or with a hex wrench.

Richco Plastic Co. **CIRCLE 92**

Adhesive Level Controls

The Glue Spy 100 and 200 eliminate product loss due to missing adhesive, charred hot melt, or overfilling. Controls come equipped with one or two sensors that combine with alarm systems or automatic filling devices that guarantee proper levels in hot or cold glue applicators. Using an automatic safety device, the Glue Spy sensor also prevents false alarms when opening the lid of an adhesive tank. Infrared sensors for distances ranging from 20 to 50 mm are available to compensate for different surfaces or distances between the sensor and adhesive levels.

Meltex Corp. **CIRCLE 93**

Surface Mount Reflow

The SMD-1422 convection/infrared system can process reflow at speeds up to 8 fpm. It can also pre-bake solder paste and epoxy cure at much faster speeds. Vitro-foil® panel emitters ensure temperature control and eliminate component shifting, misalignment, and tombstoning. The computer control system stores up to 99 profiles. The 1422 is available with a chain/rail conveyor transport system for ease of processing double-sided SMD reflow.

Vitronics Corp. **CIRCLE 94**

Microminiature Connectors

A series of co-axial, 2-, 4-, 7- and 12-contact units with miniature cables for each series consists of plugs, receptacles and jacks. The line provides sufficient off-the-shelf parts to meet most design requirements where size and weight must be minimized. Only the plugs and receptacles or solder mounts of the various configurations are shown. Parts may be assembled without special tooling.

Microtech, Inc. **CIRCLE 95**

Syringe Adapter

Available in four sizes, the KDS eliminates production downtime that may occur when syringes on hand are from the wrong manufacturer, as well as the need to carry back-up parts to accommodate various manufacturers' configurations. Among its features is a metal holding fixture that gives the adapter long life and avoids plastic fatigue. It also uses a locking gasket, preventing leakage even at high pressure; a 360° hose swivel makes the unit easy to handle.

Kahnetics Dispensing Systems **CIRCLE 96**

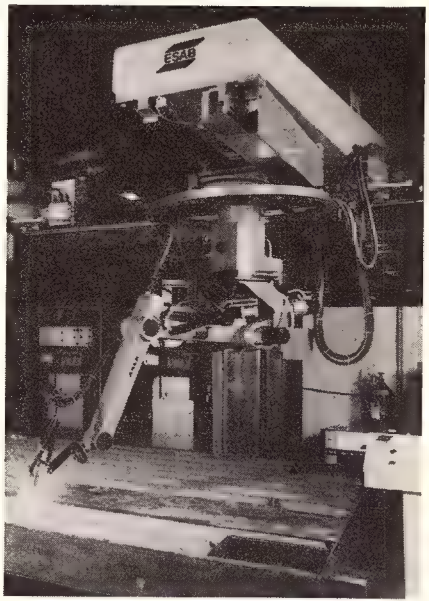
Adhesive Sealant

The products use a unique dispenser that permits regulation of sealant flow rate and bead width more precisely. It is suggested for sealing, bonding, insulating, and gasketing in both production-line and plant maintenance applications.

GE Silicones **CIRCLE 97**

Cantilever Track System

An overhead system allows welding robots to be mounted above the factory floor, allowing maximum use of work area. Robots can access workpieces from five different aspects, four sides and the top, which results in a generous work envelope. The Orbit Track System can also be installed close to a wall to create an open, easily accessible work area. With this configuration, operators can load, unload, and process workpieces conveniently. The IRB L6/2, IRB G6/2 and IRB 2000 robots can be used.



ESAB North America **CIRCLE 98**

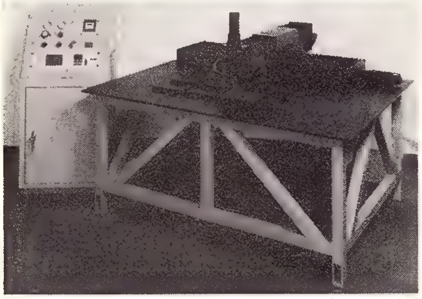
Hanging Bracket

The HB is recommended for use with #6 or #2 screws, allowing for greater mounting options. The bracket keyslot accepts a #10 screw maximum head diameter 0.350 mm and maximum head thickness 0.185 mm, and holds in excess of 75 lbs, depending on screw size used.

Richco Plastic Company **CIRCLE 99**

High-Speed Dispensing

The ICONomiser LD10008 offers complete bead control and precise pattern accuracy for hot melt, RTV, 1 or 2 part epoxy, urethane, solder paste and other liquid materials. The continuous path feature allows rapid changes in motion, eliminating irregular line thickness and material puddling in corners. The system has a motion range of 6 x 6 in. up to 24 x 24 in. with rapid traverse rates of up to 1000 ipm. Repeatability of 0.0005 in., resolution of 0.0005 in., and table accuracy of 0.001 ipi are attainable. A programmable Z-axis slide provides 2 in. of motion at 0.0005 in. resolution.



Automation Unlimited **CIRCLE 100**

Clean Room Robot

A clean room version of the 1400 robot, tested to class 100 clean room standards, has applications such as hard disk drive assembly where its rapid cycle time and 0.001 in. repeatability can increase manufacturing throughput. The 1400C robot also features 0.002 in. accuracy, a measure of position performance when the manipulator is guided by the IntelleVue 200 computer vision system, or when data is downloaded from a CAD system. It can be programmed off-line, outside the clean room, on an IBM compatible personal computer.

Intelledex **CIRCLE 101**

No Ozone

Activfilter™ Media features a very fine granular absorbent chemically bonded to the substrate to maximize surface area accessible for ozone removal and minimize "brush-off." Suitable for workstation filtration systems where laser cutting, laser and arc welding, engraving or other processes are involved, this media reduces ozone below the OSHA limit of 0.1 ppm. The medias can also remove odors, irritants, pollutants, and most toxic gases.

Lewcott Corp. **CIRCLE 102**

Reflow Solder

The LB10 automatic light-beam reflow soldering system for SMDs is controlled by a personal computer. Twice as fast as laser soldering, it can reflow quad-pack in 4-5 sec without heating the component's body, and its X-Y table positions pc boards to ±0.1 mm. In automatic mode, the LB-10 solders all programmed locations in sequence. In semiautomatic, it solders one component at a time. Input/output conveyors make it a continuous, in-line operation.

Electrovert USA Corp. **CIRCLE 103**

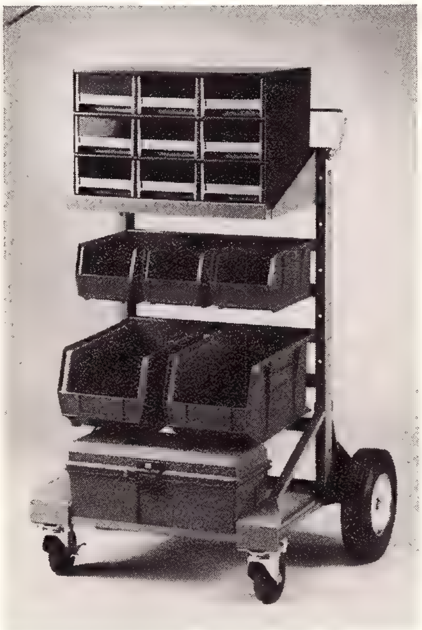
A Good Grip

Non-contact sensors mounted in these gripper fingers monitor finger travel to determine finger position. The electronic sensing unit provides up to 6 separate outputs corresponding to 6 possible finger positions. Two of the 6 outputs are preset to monitor for full finger open and closed position. Remaining 4 output positions are programmable and may be used as a reference point for part identification. Small unit resolution allows the sensor to differentiate between very similar parts and determine whether a part has been accurately grasped.

Barry Wright Corp. **CIRCLE 104**

Help On Wheels

Rugged service cart carries up to 500 lbs of tools, parts, or repair equipment. The cart is made of 16-gauge steel and features a sturdy steel handle, 10 in. rubber-tired rear wheels and two swivel casters in front for easy maneuverability. Unit measures 23 in. wide for clear passage through doorways or where space is limited. The 19.75 in. top shelf will support heavy tool boxes or maintenance equipment. Cart does come with 16 x 9 x 7 in. tool box with lift-out tray, locking latch and carrying handle, plus 5 bins and a parts cabinet with 20 removable drawers.



Jensen Tools Inc. **CIRCLE 105**

THE ONE SOLDERABILITY TESTER THAT DOES IT ALL

A simple preventive test that can eliminate hours and the cost of rework.

Tests solderability of plated through-holes (PTH's). PC boards. And component terminations.

Performs wetting balance. Edge dip. Globule. And PTH solderability tests to specification.

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Using an IEEE 488 interface the instrument can be computer controlled. Specially prepared programs display step-by-step operator instructions and provide a display/print of all results including the wetting balance curve.

It's the ideal system to determine the solderability of your parts before and during production.

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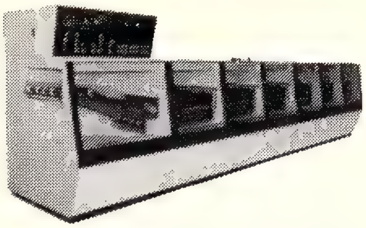
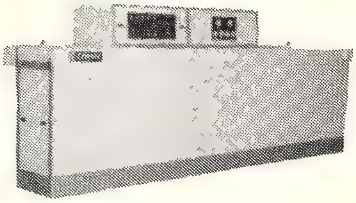
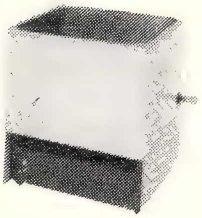


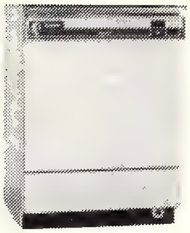
Six Stage Aqueous Cleaner



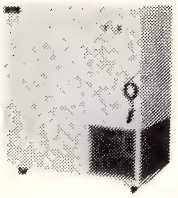
Conveyorized Vapor Degreaser



Bench Top Ultrasonic Cleaners



Batch Spray Washer



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CIRCLE 405 on reader information card

Tube Toaster

The Model 4810 applies controlled, uniform infrared heat to slender, cylindrical products. Typical applications include shrink tubing, reflowing solder, brazing joints and low temperature heat treating and softening. The heater can be preset to a desired temperature within a range of 300 to 800°C. Cycle time can be reset over a range of 1 to 99 sec. The part automatically ejects from the heater cavity. Toaster is available with chamber lengths of 1 1/2, 3 and 6 in.
Research Inc. **CIRCLE 106**

Design For Assembly Software

The DFA Toolkit, offered as a complete package of four programs, assists in simplifying product design, assessing assembly costs, and choosing which method of assembly is appropriate—manual, automatic, or robotic. Four toolkit modules address assembly system economics simulation, design for manual assembly, design for robot assembly, and design for automatic assembly and handling.
Boothroyd Dewhurst, Inc. **CIRCLE 107**

Ultrasonic Bolt Measurement

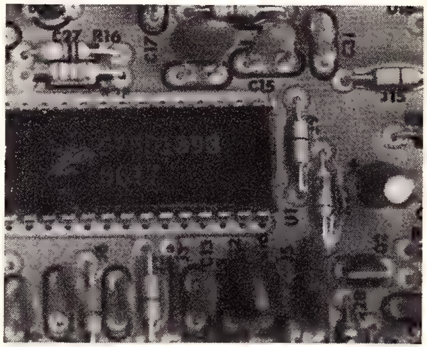
BoltMaster measures stretch, stress, and load, and its programmable, touch-sensitive display simplifies ultrasonic bolt load determination: a keypad system ensures that the operator will see only those keys required for each step of the procedure. The new computer component stores thousands of bolt measurements in memory, and can download data into an IBM or compatible system.
Raymond Engineering, Inc. **CIRCLE 108**

Check Gage

New gage provides a quick, accurate method of checking the repeatability of robot arms. The six precision dial indicators measures the robot face plate location five ways at one time to determine the extent of wear or damage due to a crash. The sturdy frame allows displacement readings with 0.001. The RBC-3000 gage will fit most roots with face plates from 5 in. to 9 in. in diameter.
Tring Corp. **CIRCLE 109**

UV Conformal Coating

Light-Weld 984 cures in as little as 5 sec using high intensity ultraviolet lamps. It is designed for ease of spraying using common air or airless type spray systems. Controlled films from 2 to 5 mil thickness can be applied and cure to a tough coating that resists moisture, salt spray, solvents and temperatures of −40 to 300°F. Boards can be repaired and immediately resealed by reapplying 984 and curing with UV light.
Dymax Engineering Adhesives **CIRCLE 110**



Hex Keys

A full line of ballpoint hex keys in sizes from 0.05 to 3/8 in. permit angled entry and full socket engagement. Socket screws can be tightened at angles up to 30°, allowing access to sockets located in confined areas. Alignment of socket and wrench is facilitated by the ballpoint tip, even in areas of limited visibility. A screwdriver-type and an L-wrench shape are available.
SPS Technologies **CIRCLE 111**

Soldering With 15 to 50 Watts

Antex soldering irons include two temperature controlled models plus four regular irons. Featuring their heating elements under the tip for optimum thermal efficiency, they accept over 40 different slide-on tips with point sizes from 3/16 to 0.01 in. diameter. Ready to solder in just 45 sec, the irons provide quick recovery times after soldering. Tip is directly grounded through the 3-pronged plug.
M.M. Newman Corp. **CIRCLE 112**

Double-Sided Foam Tape

Duofoam S-131, coated on both sides with an acrylic pressure-sensitive adhesive, has high tensile strength, adheres to irregular surfaces, exhibits excellent long-term aging properties and withstands environmental extremes. It die cuts cleanly, and the film release liner won't bubble when applied to wound profile extrusions. Typical applications include mounting automotive body side molding and reflectors and for gasketing.
Coating Sciences, Inc. **CIRCLE 113**

Butterfly In The Hand

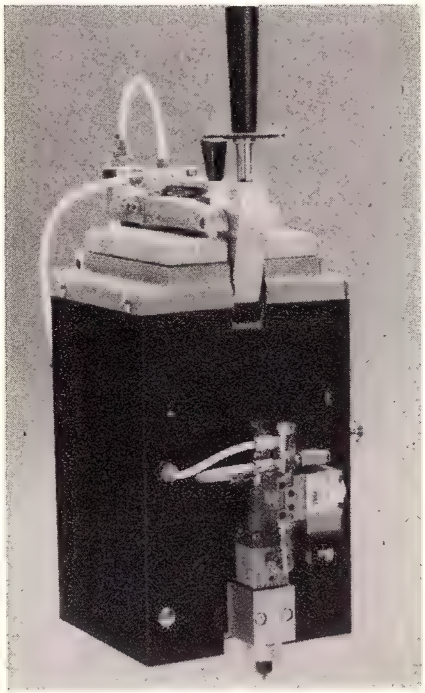
This splice welding handgun is designed to meet advanced assembly operations. The unit can be used on assembly boards, conveyors, automatic lines, and wherever space is limited. In addition to hand-held operation in either the right or left hand, the Butterfly can be mounted on a table or assembly board and activated by a footswitch. At only 2.5 lbs, this unit can also be maneuvered in and around a complex wiring harness as it is being assembled on a fixture.
STAPLA Ultrasonics Corp. **CIRCLE 114**

Stable Solder Creams

Non-hydroscopic solder creams, with tack time over 48 hrs, resist oxidation ensuring reliable screening and reflow performance in production. Proprietary flexible package permits addition of premeasured amounts of cream to the screen and eliminates physical contact with the paste. Creams are guaranteed not to separate or harden for 12 months at room temperature. ESP creams are available in screening, stenciling, and dispensing grades.
ESP **CIRCLE 115**

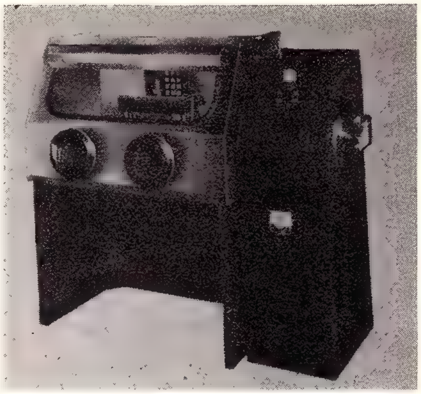
Hot Melt Applicator

The MP401(S) offers numerous options. For instance, the amount of adhesive to be discharged can be set with the air supply valve. By changing the position of the nozzle module, adhesives can be applied from the top as well as from the side. For bonding or coating larger surfaces sensitive substrates, a spray version is available with 1 or 2 spray nozzles.
Meltex Corp. **CIRCLE 116**



Modular Welding

The Accu-Weld Venus 7100, 5100 and 4100 resistance welders are designed modularly to client specification, with atmosphere chamber, oven, pass-thru and power supply required. Moisture monitors, gas dryers, current analyzers, data acquisition systems and other features may be added as technology and requirements change and production levels increase.
Polaris Electronics Corp. **CIRCLE 117**



Soldering Monitor

Flowtrack II can be directly wired in to a machine's 120-volt electrical system to make it a permanent part of a wave solder unit. It monitors all vital functions and prints on an integral thermal printer. Machine parameters include solder-wave temperature, preheat, exhaust stack, solder pot temperatures, conveyor speed and date. In addition, the unit automatically controls density of flux and monitors other flux characteristics such as temperature, level, and air pressure.
Electronic Controls Design **CIRCLE 118**

High Performance Irons

The SA-8 Series features a silicone rubber heat guard allowing the grip to remain at a constant low temperature. Ergonomic design maximizes accuracy. Short heat-up time and efficient temperature recovery assures quick and easy handling of all soldering applications.
OK Industries, Inc. **CIRCLE 119**

Soldering/Desoldering Tool

The Labor S works contact-free on SMD and DIP components in 2-4 seconds, using a stream of hot air. Temperatures are adjustable between 20 and 600°C. The tool has 4-way desoldering slip-on nozzles for flat packs and DIP cases. Using controlled hot air to solder components decreases circuit board degradation and can increase reliability of solder joints. The tool can also shrink-on sleeves and parts, and shrink wrap plastic packaging of electronic parts.
Brian R. White Co., Inc. **CIRCLE 120**

ANCHOR'S
TAP FORM™
roll-forms its own perfectly mated threads

Anchor's new high performance thread forming screw helps cut production costs!

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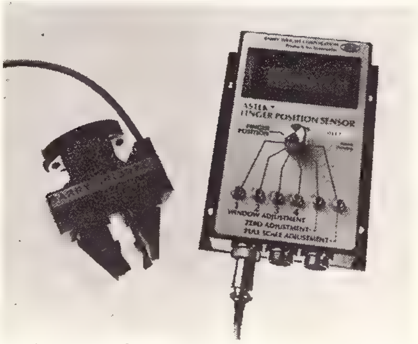
Soldering Power Supply

The Phasemaster IVB controls the complete soldering process and, when interfaced with a personal computer, also provides data logging capability mandated by documentation requirements of DOD-STD-2000. Multiple, user-programmed soldering schedules protect temperature-sensitive components. Soldering polyimide and uninsulated flat cables to circuit boards or connectors are typical applications. The unit is also adapted to soldering and reworking SMT boards.
Unitek Corporation Equipment Div.
CIRCLE 121

Optical Epoxy

EPO-TEK 328 is a 100% solids system recommended for applications where a low refractive index is required. This optically transparent epoxy system can be used for bonding or coating glass, quartz, metals, sapphire, Pyrex, ceramic, and most plastics. The epoxy can be applied by dipping, spinning, brushing or with dispensing equipment. It features a two day pot life, viscosity of 3500 cps, a glass transition temperature of 110°C and a lap shear strength of 1000 psi. Its shelf life at room temperature is one year, and refrigeration is not required.
Epoxy Technology, Inc. **CIRCLE 122**

Automated Workcell



The Multi-Link™ tool changing system enables a single robot to perform high tolerance assembly, close clearance insertion, and use an Astek™ 6-axis force sensor to search an area for randomly placed parts. System offers an unlimited number of tasks to be performed by a single workcell.
Barry Wright Corp. **CIRCLE 123**

Set Screw Collars

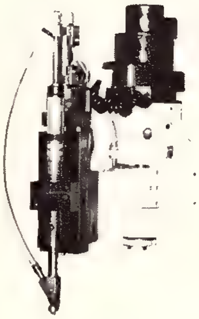
These steel collars have plain, plated and black oxide finishes and are made from Type 303 stainless steel. They are GSA classified under Federal Supply Class 3040-3. Featuring 43 standard sizes from 1/8 to 3 in. bore, they are available off-the-shelf. Couplings from 1/2 to 1 1/2 are also offered.
Stafford Manufacturing Corp. **CIRCLE 124**

Case Hardening

Induction heating that case-hardens the leading threads of self-tapping fasteners allows the fastener to tap easily, and does not affect the metal's strength throughout the balance of the fastener. In addition, the speed and efficiency of this process allow production rates of up to 400 parts per min.
The Taylor-Winfield Corp. **CIRCLE 125**

Electronic Hardware

New line includes nylon cable clamps; steel, nickel plated hole plugs; ceramic standoffs made of L5 ceramic, glazed; recessed rubber and vinyl bumpers; rubber grommets and nylon shoulder washers/bushings. Company also maintains complete tooling and fabricating facilities.
Keystone Electronics Corp. **CIRCLE 126**



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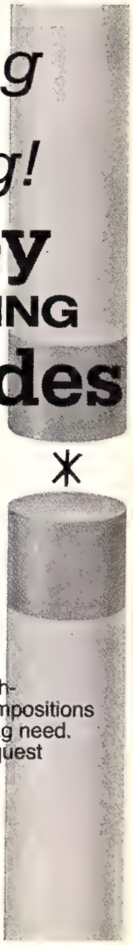

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An award honoring an individual whose leadership in advancing the state-of-the-art in product assembly has strengthened his or her company's competitive position in the global marketplace.

The competition gets tougher every year. Manufacturing companies everywhere are working harder than ever to strengthen their competitive positions and gain market share. Any program focusing on these goals is, inevitably, a team effort. And the team usually includes one person who champions the application of leading-edge manufacturing assembly technology and innovative manufacturing management methods. This individual is typically a dedicated professional who addresses the pursuit of manufacturing excellence not as a goal, but as a never-ending process; a "forever war" on inferior performance.

Assembly Engineering honors one such manufacturing professional each year with the Productivity through Assembly Technology (PAT) Award.

CALL-FOR-ENTRIES

Assembly Engineering announces the Call-For-Entries in the 1988 PAT Award competition. Entries are invited from individuals who have made the commitment to excellence in assembly productivity, and who have been instrumental in developing and implementing projects or programs with measurable progress toward fulfilling that commitment.

Programs for which their leaders have won PAT Awards in past years include the application of sophisticated manufacturing and assembly automation systems, development of superior management methods and techniques, major innovations in product design concepts, and application of advanced manufacturing hardware or software.

JUDGING CRITERIA

The purpose of the PAT Award is to recognize individual accomplishment, performance improvement, and results. The judges will evaluate entries on the basis of criteria such as:

- Increased productivity
- Improved product quality
- Reduced manufacturing cost
- Increased sales
- Overall return-on-investment
- Increased market share
- Increased customer satisfaction
- Reduced scrap
- Reduced turnaround time from quote to delivery
- Reduced Work-In-Process
- Increased inventory turnover

Therefore, entrants are strongly encouraged to supply as much hard data and documentation on these subjects as their companies' policies permit, as well as any other appropriate material, to assist the judges in their task.

The judges will also evaluate the entries on the basis of:

- Contribution to the state-of-the-art in the assembly of manufactured products.
- Significance to the entrant's industry, and to the manufacturing community as a whole.
- Degree of innovation, particularly in terms of departure from generally accepted or traditional practices.

DEADLINE

All entries must be received by *Assembly Engineering* no later than June 1, 1988, and must be accompanied by a completed PAT Award Entry Form (overleaf). All entries become the exclusive property of *Assembly Engineering*. Judging will be performed by the Assembly Engineering Editorial Staff and Editorial Advisory Board. All decisions are final.

The 1988 PAT Award will be presented during a special luncheon at the 9th annual ASSEMBLY Technology Expo and Conference, September 20-22, 1988 at the O'Hare Expo Center, Rosemont, Illinois. The 1988 PAT Award winner will also be featured in the October, 1988 issue of *Assembly Engineering*.

To obtain additional entry forms, or for more information, please write to:

1988 PAT Award Program
Assembly Engineering
25W550 Geneva Road
Wheaton, IL 60188

or **Circle No. 300** on the Reader Service Card in this issue.

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PAT Award Entry Form

Name____________________

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Company____________________

Address____________________

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Name of program/project in which you participated____________________

Specific goals & objectives of your program/project____________________

Elapsed time from inception to operational status____________________

Person authorizing release of information
to *Assembly Engineering*____________________

Title____________________

Signature & Date____________________

NARRATIVE: Please describe in detail the goals, execution, and—above all—the results of the program/project in which you participated. Please refer to the section entitled JUDGING CRITERIA (overleaf) for the information and material needed to evaluate the PAT Award entry. You are strongly encouraged to include photos, drawings, charts, and other visual material to complement the text, especially in those areas that address objectives and results.

Please attach completed Entry Form to the package containing the Narrative and all other supporting material and mail to:

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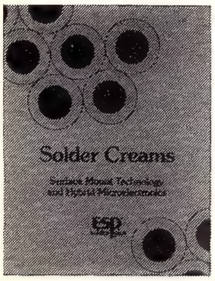
FREE LITERATURE

Conical Washers

Four-page catalog shows a line of Belleville-type washers that, when torqued flat, store large amounts of compressive energy against heat and vibration indefinitely. Included are charts covering materials, load and deflection by bolt size, and ID for many standard stocked sizes. Washers are supplied in 301 and 17-7PH stainless, in addition to AISI 6150 alloy steel. Also offered are phosphor bronze and Inconel 718 washers.

Solon Manufacturing Co. **CIRCLE 201**



Solder Creams

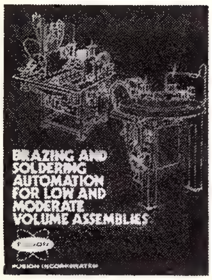
Technical brochure describes new line for surface mount and hybrid microelectronic applications. These creams feature long tack time, pattern definition, and reliable reflow performance. Screening, stenciling, and automatic dispensing grades are available.

ESP **CIRCLE 202**

Materials for Fasteners

Camloc™ Cases 12, describes trends and new developments in engineered fasteners. Trends toward low cost, multiple functions, and miniaturization are covered. Among the new designs discussed is the adjustable zero gap fastener that ensures positive locking between panel and frame. As a result, vibration cannot pull the fastener stud and receptacle apart or from the panel or frame.

Rexnord Specialty Fastener Div. **CIRCLE 203**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Fusion Machine

A four-page brochure details two new machine concepts: the Shuttle Machine and the Economy Rotary. Both are designed to aid mid-volume manufacturers in automating their brazing and soldering operations. The Shuttle Machine (36 in. wide x 55 in. high) is aimed at volumes in the 100,000-400,000 parts per year range and is capable of soldering two to four assemblies of 60 to 200 parts per hour.

Fusion **CIRCLE 204**

Belt Fastening

The 24-page book includes special sections on proper splice techniques and a quick-reference trouble-shooting guide. It also provides information on how to specify and use the company's belt splicing products. This includes an easy-to-follow hook chart and pin guide, a convenient product cross reference, both by industry and by belt system specs, and descriptions of fasteners, lacers, connecting pins, and splicing accessories.

Clipper Belt Lacer Co. **CIRCLE 205**

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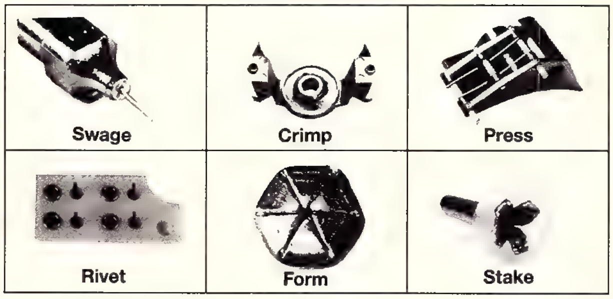

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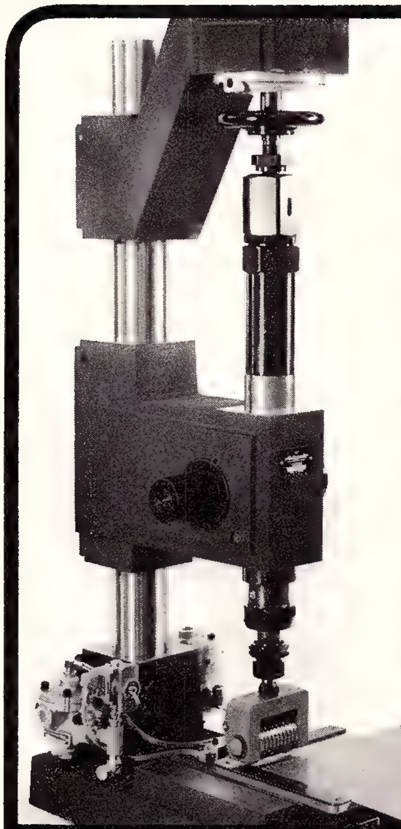

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Modular Assembly Conveyors

Four-page technical brochure describes lines of systems for flexible assembly. It provides a narrative on features and benefits of two systems, plus line drawings and exploded views. Fast-Flex is a modular, aluminum extrusion, power and free, belted assembly conveyor system specially designed for small parts assembly. Flex-Mate is a standard design for low to medium volume parts assemblies; it consists of a Fast-Flex conveyor and an assembly robot mounted on a base to produce a stand-alone system.
Alliance Automation Systems **CIRCLE 206**

Microminiature Connector

Illustrated, 28-page catalog provides info and specs on the Nano system, which gives four times the I/O of conventional insulation displacement connectors in the same board area, or the same amount of I/O with a 75% reduction in board space. In addition, the connector offers designers twice the cost-efficiency of conventional IDC units.
CW Industries **CIRCLE 207**

Powder Metal Fasteners

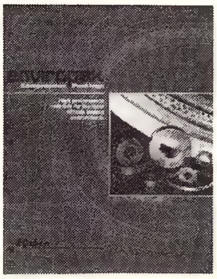
Guide covers design criteria for close tolerance special pattern nuts and inserts with simple graphics. This technology virtually eliminates secondary operations and is a cost effective alternative to stamped, headed, and machined parts.
Midwest Sintered **CIRCLE 208**

Banding Tools

New catalog describes stainless steel clamps, bands, buckles, and tools, complete with specs, technical data, and illustrations of typical product applications. These items are used for fastening hoses, pipes, signs, and a variety of industrial applications in general manufacturing, energy, marine, mining, agriculture, as well as building and construction.
TESPA Clamp & Band, Inc. **CIRCLE 209**

Dispensers

The 20-page catalog of dispense equipment contains indications of the extent of special design capability dedicated to the preparation of completely independent dispense stations.
Tridak Div. **CIRCLE 210**



Compression Packing

New brochure discusses properties, performance characteristics, temperature limits, pH range, and shaft speeds for 12 premium grade, non-asbestos packings.
Robco Inc. **CIRCLE 211**

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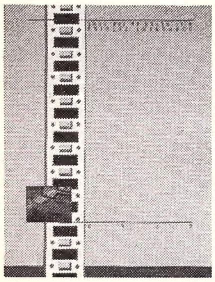
Electronic Hardware

The 6-page catalog includes part abbreviations, available materials, thread sizes, and a general description of usage. Of special interest is the addition of several new products developed by precision die-casting including threaded and unthreaded zinc alloy spacers, and threaded zinc alloy ultrasonic inserts.
Standard Insert Co. **CIRCLE 212**



Components Tape

Brochure provides an overview of GPAX, a tape-and-reel packaging system for odd-form and other components. GPAX is an automation package for use in robotic assembly. Package contents are dispensed directly to a robot for assembly with a printed circuit board or other final assembly. The brochure outlines the merits of a continuous automation package as well as defining the process.
Gelzer Development Co., Inc. **CIRCLE 213**

Precision Hand Tools

Full-color 20-page catalog provides a complete account of precision tweezers used in electronic assembly. The catalog contains Dumont and Boley style tweezers, as well as new aluminum and ceramic tipped tweezers. Also included are miniature, cross-action, and the new component handling tweezers.
Intrade, Inc. **CIRCLE 214**

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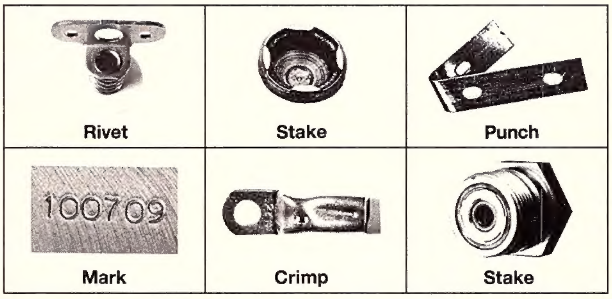

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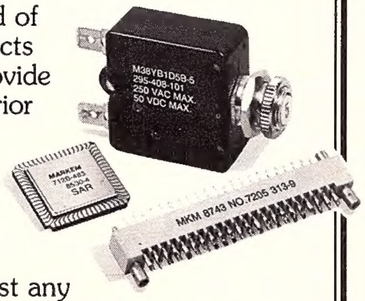

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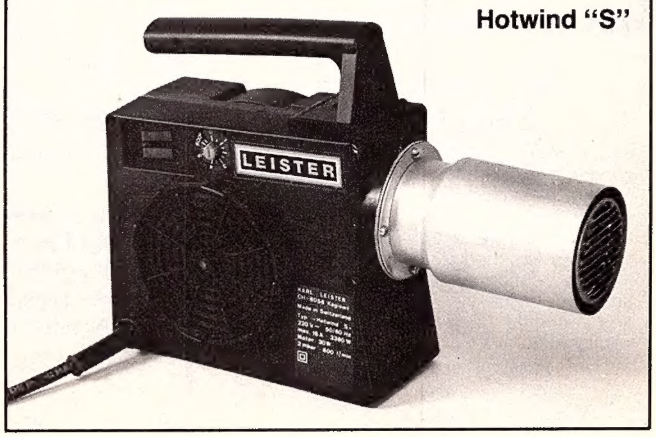

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AD INDEX

Alliance Automation Systems, Inc. . . . 27
American Seating Co. . . . 47
Anchor Bolt & Screw Co. . . . 77
Apex Div., Cooper Industries, Inc. . . . 53
Assembly Automation . . . 78
ASSEMBLY Technology Expo . . . 64
Autojectors, Inc.. . . . 58
Automation Tooling Systems . . . 19
Automator Div., Mecco Corp. . . . 81
Bimba Manufacturing Co. . . . 26
Black & Webster . . . 81, 83
Bodine Corp., The. . . . 9-12
Branson Ultrasonics Corp.. . . . 36
Bronson Co., The Homer D. . . . 63
Cahners Exposition Group . . . 59
Chicago Pneumatic Tool Co.. . . . 20-21
Clippard Instrument Laboratory, Inc. . . 40
ConProTec, Inc.. . . . 58
Deltrol Fluid Products . . . 82
Desoutter Inc.. . . . 28
Dorner Manufacturing Corp. . . . 65
Dynapace Corp.. . . . 34
EFD Inc. . . . 4
Elco Industries . . . 41
Emerson & Cuming . . . Cover 2
Fusion, Inc. . . . 54
GMF Robotics . . . 48
GSE, Inc. . . . 36
Gilman Engineering, . . . 37
  Unit of Giddings & Lewis
Hamilton-Pax, Inc.. . . . 36
Heller Industries Inc.. . . . 35
Hitchcock Executive Book Service . 66-69
Hogen Industries . . . 78
IBM . . . 6-7
IKO International, Inc. . . . 42
Industrial Krazy Glue . . . 40
Intelledex . . . 1
Jackson Machine Products . . . 62
Joraco, Inc. . . . 64
KMC Stampings Div., . . . 73
  Kickhaefer Mfg. Co.
Keyence Corp. of America . . . 82
Kingsbury Machine Tool Corp. . . . 2
Lenape Systems . . . 76
Liquid Control Corp. . . . 56
Loctite Corp. . . . Cover 4
Lumonics Marking Corp.. . . . 55
Markem Corp. . . . 83
Marson Corp. . . . 71
Mountz, Inc. . . . 58
Multicore Solders . . . 75
New England Affiliated
  Technologies, Inc.. . . . 58
Nordson Corp. . . . Cover 3
Nylon Molding Corp.. . . . 65
POP Fasteners Div.,. . . . 51
  Emhart
Panduit Corp. . . . 40
Parker Hannifin Corp., . . . 17
  Cylinder Div.
Precision Metal Products Co., Inc. . . 56
Reader Information Card . . . 49-50
Seiko Instruments USA . . . 43
Spirol Automation Products . . . 16
Stick Screw Div. of Ripley . . . 61
Stimpson Co., Inc.. . . . 28
Thomson Industries, Inc.. . . . 14-15
Tohnichi America Corp. . . . 61
Transfer Print America Inc.. . . . 73
Universal Instruments Corp. . . . 29
Visumatic Industrial Products, Inc. . . 70
White Co. Inc., Brian R. . . . 83
Xenon Corp. . . . 72

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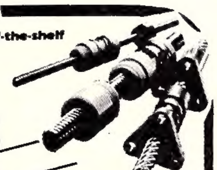

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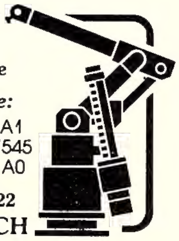

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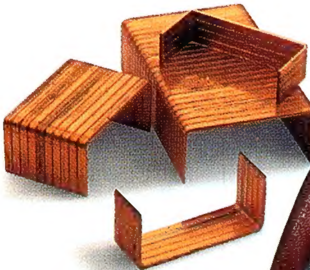

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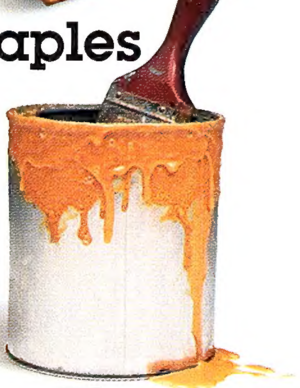
Screws

Tape



Glue

FoamMelt® Process

Why has the Nordson® FoamMelt ® process replaced so many other assembly methods?

Because it's long on bonding power, versatility and savings. And it's short on adhesive consumption, time and labor. By combining inert gas with hot melt adhesive, this patented process generates the foam that makes it so effective.

It's ideal for all kinds of bonding, sealing, caulking and gasketing jobs. Works beautifully in many applications where standard hot melts don't, such as bonding plastic films. The savings in time and money are especially strong in automated, high-production operations.

The long and short of it is that the FoamMelt process is making assembly history every time it goes to work.

To see for yourself what this revolutionary Nordson system can do, call 1-800-621-6413 (in Illinois 1-800-562-5200, ext. 356) and we'll send you our free videotape demonstration. Then think about what the FoamMelt process can do for you.

Nordson Corporation, 350 Research Court, Technology Park/Atlanta, Norcross, Georgia, 30092.

Nordson®

CIRCLE 351 on reader information card

NEXT TIME THE CHIPS ARE DOWN, CALL LOCTITE.

Lost chips. Sliding chips. Adhesive oozing onto solder pads. Just a few of the SMT problems often blamed on the placement machine but, in fact, they're usually caused by adhesive failure. It's time to stick it to your old adhesive – and cure production problems – with Chipbonder™ adhesive from Loctite.

High green strength prevents skewing and tombstoning.

Won't migrate when heated. Assures good soldering results.

Controlled viscosity eliminates stringing and contamination.

Loctite Chipbonder adhesive gives you higher dot height and faster curing to keep chips in place. It won't string during dispensing and won't flow during soldering – so parts and pads stay clean. And its controlled strength makes chip replacement easy.

Get the high performance adhesive designed for high performance assembly. Loctite Chipbonder adhesive. Call us today for immediate assistance or for our free "Solutions to Process Problems" brochure. (203) 246-1223.

Airless packaging ends dot inconsistency. One year shelf life at room temperature. Packages for major machines.

LOCTITE®
Chipbonder Adhesive

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